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EQUATIONS, TABLES, and CHARTS for COMPRESSIBLE FLOW

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SUPERSONIC AERODYNAMICS

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REPORT 1135

EQUATIONS, TABLES, AND CHARTS FOR COMPRESSIBLE FLOW

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Conduct, under unified control, for all agencies, of scientific research on the fundamental problems of flight

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REPORT 1135

EQUATIONS, TABLES, AND CHARTS FOR COMPRESSIBLE FLOW [1]

By Ames Research Staff

SUMMARY

This report, which is a revision and extension of NACA TN 1428, presents a compilation of equations, tables, and charts useful in the analysis of high-speed flow of a compressible fluid. The equations provide relations for continuous one-dimensional flow, normal and oblique shock waves, and Prandtl-Meyer expansions for both perfect and imperfect gases. The tables present useful dimensionless ratios for continuous one-dimensional flow and for normal shock waves as functions of Mach number for air considered as a perfect gas. One series of charts presents the characteristics of the flow of air (considered a perfect gas) for oblique shock waves and for cones in a supersonic air stream. A second series shows the effects of caloric imperfections on continuous one-dimensional flow and on the flow through normal and oblique shock waves.

INTRODUCTION

The practical analysis of compressible flow involves frequent application of a few basic results. A convenient compilation of equations, tables, and charts embodying these results is therefore of great assistance in both research and design. The present report makes one of the first such compilations (ref. 1) more readily available in a revised and extended form. The revisions include a complete rewriting of the lists of equations, as well as the correction of certain typographical errors which appeared in the earlier work. The extensions are primarily in the directions dictated by increasing flight speeds, that is, to higher Mach numbers and to higher temperatures with the accompanying gaseous imperfections.

Compilations similar to those of reference 1 have been given in other publications, as, for example, references 2 through 6. These references have been utilized in extending the tables and charts to higher values of the Mach number. The extension to imperfect gases is based on the relations presented in references 7 and 8.

SYMBOLS AND NOTATION

PRIMARY SYMBOLS

	speed of sound
	cross-sectional area of stream tube or channel
C_N	normal-force coefficient for cones, $\frac{\text{normal force}}{q_\infty S_b}$
c_p	specific heat at constant pressure
c_v	specific heat at constant volume
h	enthalpy per unit mass, $u+pv$
l	characteristic reference length
M	Mach number, $\frac{V}{a}$
p	pressure [2]
q	dynamic pressure, $\rho V^2/2$
q	heat added per unit mass
R	gas constant
R	Reynolds number, $\frac{\rho V l}{\mu}$
S_b	base area of cone
s	entropy per unit mass
T	absolute temperature [2]
u	internal energy per unit mass
v	specific volume, $\frac{1}{\rho}$
u,v	velocity components parallel and perpendicular respectively, to free-stream flow direction
$\bar{u}$, $\bar{v}$	velocity components normal and tangential, respectively, to oblique shock wave
V	speed of flow
V_m	maximum speed obtainable by expanding to zero absolute temperature
w	external work performed per unit mass
α	angle of attack
β	$\sqrt{\lvert M^2-1\rvert}$
γ	ratio of specific heats, $\frac{c_p}{c_v}$
δ	angle of flow deflection across an oblique shock wave
θ	shock-wave angle measured from upstream flow direction
Θ	molecular vibrational-energy constant
μ	Mach angle, $\sin^{-1}\frac{1}{M}$
μ	absolute viscosity
ν	Prandtl-Meyer angle (angle through which a supersonic stream is turned to expand from $M=1$ to $M>1$)

[1] Supersedes NACA TN 1428, "Notes and Tables for Use in the Analysis of Supersonic Flow" by the Staff of the Ames 1- by 3-foot Supersonic Wind-Tunnel Section, 1947.
[2] When used without subscripts, p, ρ, and T denote static pressure, static density, and static temperature, respectively

ξ pressure ratio across a shock wave, $\frac{p_2}{p_1}$

ρ mass density [2]

σ semivertex angle of cone

SUBSCRIPTS

∞ free-stream conditions

1 conditions just upstream of a shock wave

2 conditions just downstream of a shock wave

t total conditions (i. e., conditions that would exist if the gas were brought to rest isentropically)

$*$ critical conditions (i. e., conditions where the local speed is equal to the local speed of sound)

c conditions on the surface of a cone

r reference (or datum) values

perf quantity evaluated for a gas which is both thermally and calorically perfect

therm perf quantity evaluated for a gas which is thermally perfect but calorically imperfect

$(\ )_p$ derivative evaluated at constant pressure

$(\ )_s$ derivative evaluated at constant entropy

$(\ )_T$ derivative evaluated at constant temperature

$(\ )_v$ derivative evaluated at constant specific volume

$(\ )_{rev}$ quantity evaluated over a reversible path

NOTATION

The notation in brackets [ ] after many of the equations signifies that the equation is valid only within certain limitations. For example:

[perf] means that the equation is restricted to a gas which is both thermally and calorically perfect. (By "thermally perfect" it is meant that the gas obeys the thermal equation of state $p=\rho RT$. By "calorically perfect" it is meant that the specific heats c_p and c_v are constant.)

[therm perf] means that the only restriction on the gas is that it must be thermally perfect. Equations so marked may be used for calorically imperfect gases. (They are, of course, also valid for completely perfect gases.)

[isen] means that the flow process must take place isentropically. Equations so marked may not be applied to the flow across a shock wave.

[adiab] means that the only restriction on the flow process is that it must take place adiabatically—that is, without heat transfer. (Such a flow process may or may not be isentropic depending on whether it is or is not reversible.) Equations so marked may be applied to the flow across a shock wave.

An equation without notation has no restrictions beyond those basic to the study of thermodynamics and/or inviscid compressible flow.

[2] When used without subscripts, p, ρ, and T denote static pressure, static density, and static temperature, respectively.

FUNDAMENTAL RELATIONS

THERMODYNAMICS

THERMAL EQUATIONS OF STATE

A thermal equation of state is an equation of the form

$$p=p(v,\ T) \qquad ($$

Several of the more commonly used thermal equations of state are the following:

Equation for thermally perfect gas

$$p=\frac{RT}{v}=\rho RT \text{ [therm perf]} \qquad (:$$

or

$$\frac{dp}{p}-\frac{d\rho}{\rho}-\frac{dT}{T}=0 \text{ [therm perf]} \qquad (:$$

Equations for thermally imperfect gas

Van der Waals' equation (ref. 9)

$$p=\frac{RT}{v-b}-\frac{a}{v^2} \qquad ($$

where a is the intermolecular-force constant and b the molecular-size constant (see ref. 9, pp. 390 et seq. f numerical values).

Berthelot's equation (ref. 7)

$$p=\frac{RT}{v-b}-\frac{c}{v^2 T}$$

where b is the molecular-size constant and c is t intermolecular-force constant (see ref. 7 for numeric values).

Beattie-Bridgeman equation (ref. 10)

$$p=\frac{RT}{v^2}\left(1-\frac{c}{vT^3}\right)\left[v+B_0\left(1-\frac{b}{v}\right)\right]-\frac{A_0}{v^2}\left(1-\frac{a}{v}\right) \qquad ($$

where a, A_0, b, B_0, and c are constants for a given g (see ref. 10, p. 270 for numerical values).

CALORIC EQUATION OF STATE

A caloric equation of state is an equation of the form

$$u=u(v,T) \qquad ($$

It can be shown that

$$du=c_v\,dT+\left[T\left(\frac{\partial p}{\partial T}\right)_v-p\right]dv \qquad (8$$

$$du=c_v\,dT \quad \text{[therm perf]} \qquad (8$$

If the gas is calorically perfect—that is, the specifi are constant—equation (8b) can be integrated to obt

$$u=c_vT+u_r \quad \text{[perf]}$$

ENERGY RELATIONS

The law of conservation of energy gives

$$\left.\begin{aligned} dq&=du+dw \quad \text{(first law of thermodynamics)}\\ &=du+p\,dv=dh-v\,dp\end{aligned}\right\} \tag{10a}$$

$$\left.\begin{aligned} dq&=c_v\,dT+p\,dv\\ &=c_p\,dT-v\,dp\end{aligned}\right\} \text{[therm perf]} \tag{10b}$$

SPECIFIC HEATS

The specific heats at constant pressure and constant volume are defined by

$$c_p\equiv\left(\frac{\partial q}{\partial T}\right)_p=\left(\frac{\partial h}{\partial T}\right)_p \tag{11}$$

$$c_v\equiv\left(\frac{\partial q}{\partial T}\right)_v=\left(\frac{\partial u}{\partial T}\right)_v \tag{12}$$

It can be shown that

$$c_p-c_v=\left[\left(\frac{\partial u}{\partial v}\right)_T+p\right]\left(\frac{\partial v}{\partial T}\right)_p=-T\frac{\left(\frac{\partial p}{\partial T}\right)_v^2}{\left(\frac{\partial p}{\partial v}\right)_T} \tag{13a}$$

$$c_p-c_v=R \quad \text{[therm perf]} \tag{13b}$$

The ratio of specific heats is defined as

$$\gamma\equiv\frac{c_p}{c_v} \tag{14}$$

According to the kinetic theory of gases, for many gases over a moderate range of temperature,

$$\gamma=\frac{n+2}{n} \tag{15}$$

where n is the number of effective degrees of freedom of the gas molecule. Useful relations for thermally perfect gases are

$$c_p=\frac{dh}{dT}=c_v+R=\frac{\gamma R}{\gamma-1} \quad \text{[therm perf]} \tag{16}$$

$$c_v=\frac{du}{dT}=c_p-R=\frac{R}{\gamma-1} \quad \text{[therm perf]} \tag{17}$$

ENTHALPY

The enthalpy of a gas is defined by

$$h\equiv u+pv \tag{18}$$

It follows that

$$\begin{aligned} dh&=du+p\,dv+v\,dp=dq+v\,dp\\ &=\left[c_v+v\left(\frac{\partial p}{\partial T}\right)_v\right]dT+\left[v\left(\frac{\partial p}{\partial v}\right)_T+T\left(\frac{\partial p}{\partial T}\right)_v\right]dv\end{aligned} \tag{19a}$$

$$dh=(c_v+R)dT=c_pdT \quad \text{[therm perf]} \tag{19b}$$

$$h=(c_v+R)T-u_r=c_pT+u_r \quad \text{[perf]} \tag{20}$$

ENTROPY

The entropy is defined by

$$ds\equiv\left(\frac{dq}{T}\right)_{rev} \tag{21}$$

It follows that

$$ds=\left(\frac{du+dw}{T}\right)_{rev}=\left(\frac{du+p\,dv}{T}\right)_{rev}=c_v\frac{dT}{T}+\left(\frac{\partial p}{\partial T}\right)_v dv \tag{22a}$$

$$\left.\begin{aligned} ds&=c_v\frac{dT}{T}+R\frac{dv}{v}\\ &=c_v\frac{dT}{T}-R\frac{d\rho}{\rho}\\ &=c_p\frac{dT}{T}-R\frac{dp}{p}\\ &=c_v\frac{dp}{p}-c_p\frac{d\rho}{\rho}\end{aligned}\right\} \text{[therm perf]} \tag{22b}$$

$$\left.\begin{aligned} s-s_r&=c_v\ln\frac{T}{T_r}-R\ln\frac{\rho}{\rho_r}\\ &=c_p\ln\frac{T}{T_r}-R\ln\frac{p}{p_r}\\ &=c_v\ln\frac{p}{p_r}-c_p\ln\frac{\rho}{\rho_r}\end{aligned}\right\} \text{[perf]} \tag{23a}$$

$$\left.\begin{aligned} s-s_r&=c_v\ln\frac{T/T_r}{(\rho/\rho_r)^{\gamma-1}}\\ &=c_p\ln\frac{T/T_r}{(p/p_r)^{(\gamma-1)/\gamma}}\\ &=c_v\ln\frac{p/p_r}{(\rho/\rho_r)^{\gamma}}\end{aligned}\right\} \text{[perf]} \tag{23b}$$

$$\frac{p}{\rho^\gamma}=\frac{p_r}{\rho_r^{\gamma}}e^{(s-s_r)/c_v} \quad \text{[perf]} \tag{24}$$

The second law of thermodynamics requires that

$$s-s_r\geqq 0 \quad \text{[adiab]} \tag{25}$$

CONTINUOUS ONE-DIMENSIONAL FLOW

BASIC EQUATIONS AND DEFINITIONS

The basic equations for the continuous flow of an inviscid non-heat-conducting gas along a streamline are as follows:

Thermal equation of state

$$\frac{p}{\rho}=RT \quad \text{[therm perf]} \tag{26}$$

Dynamic equation

$$\frac{1}{\rho}dp+V\,dV=0 \tag{27}$$

Energy equation

$$\left.\begin{aligned} du+d\left(\frac{p}{\rho}\right)+VdV&=0 \\ dh+VdV&=0 \end{aligned}\right\} \quad \text{[abiab]} \qquad (28a)$$

$$\left.\begin{aligned} c_p\,dT+VdV&=0 \\ \frac{\gamma}{\gamma-1}\,d\left(\frac{p}{\rho}\right)+VdV&=0 \end{aligned}\right\} \quad \text{[adiab, therm perf]} \qquad (28b)$$

Additional useful variables are defined as follows:

Speed of sound

$$a\equiv\sqrt{\left(\frac{\partial p}{\partial\rho}\right)_s}=\sqrt{\gamma\left(\frac{\partial p}{\partial\rho}\right)_T} \qquad (29a)$$

$$=\sqrt{\gamma\frac{p}{\rho}}=\sqrt{\gamma RT} \quad \text{[therm perf]} \qquad (29b)$$

$\cong 49.0\sqrt{T}$ ft/sec for air
if T is in degrees Rankine
(=degrees Fahrenheit+459.6) (29c)

Mach number

$$M\equiv\frac{V}{a} \qquad (30)$$

Dynamic pressure

$$q\equiv\frac{1}{2}\rho V^2 \qquad (31a)$$

$$=\frac{\gamma}{2}pM^2 \quad \text{[therm perf]} \qquad (31b)$$

INTEGRATED FORMS OF ENERGY EQUATION

The energy equation (28) can be integrated at once to obtain

$$h+\frac{V^2}{2}=\text{constant}=h_t \quad \text{[adiab]} \qquad (32a)$$

$$\left.\begin{aligned} c_pT+\frac{V^2}{2}&=c_pT_t \\ \frac{\gamma}{\gamma-1}\left(\frac{p}{\rho}\right)+\frac{V^2}{2}&=\frac{\gamma}{\gamma-1}\left(\frac{p_t}{\rho_t}\right) \\ \frac{a^2}{\gamma-1}+\frac{V^2}{2}&=\frac{a_t^2}{\gamma-1} \\ \frac{a^2}{\gamma-1}+\frac{V^2}{2}&=\frac{1}{2}\left(\frac{\gamma+1}{\gamma-1}\right)a_*^2 \\ \frac{a^2}{\gamma-1}+\frac{V^2}{2}&=\frac{V_m^2}{2} \end{aligned}\right\} \quad \text{[adiab, perf]} \qquad (32b)$$

The three reference speeds a_t, a_*, and V_m are related by

$$\left.\begin{aligned} \left(\frac{a_t}{a_*}\right)^2&=\frac{\gamma+1}{2} \\ \left(\frac{V_m}{a_*}\right)^2&=\frac{\gamma+1}{\gamma-1} \\ \left(\frac{V_m}{a_t}\right)^2&=\frac{2}{\gamma-1} \end{aligned}\right\} \quad \text{[adiab, perf]} \qquad (33)$$

PRESSURE-DENSITY RELATION

From equations (27) and (28b) it follows that

$$\frac{p}{\rho^\gamma}=\text{constant}=\frac{p_t}{\rho_t^\gamma} \quad \text{[isen, perf]} \qquad (34)$$

from which

$$\frac{p}{p_t}=\left(\frac{\rho}{\rho_t}\right)^\gamma=\left(\frac{T}{T_t}\right)^{\frac{\gamma}{\gamma-1}}=\left(\frac{a}{a_t}\right)^{\frac{2\gamma}{\gamma-1}} \quad \text{[isen, perf]} \qquad (35)$$

BERNOULLI'S EQUATION

Combination of equations (32b) and (35) gives Bernoulli's equation for compressible flow in the form

$$\frac{\gamma}{\gamma-1}\left(\frac{p_t}{\rho_t}\right)\left(\frac{p}{p_t}\right)^{\frac{\gamma-1}{\gamma}}+\frac{V^2}{2}=\frac{\gamma}{\gamma-1}\left(\frac{p_t}{\rho_t}\right) \quad \text{[isen, perf]} \qquad (36)$$

RELATIONS BETWEEN LOCAL AND FREE-STREAM CONDITIONS

With the aid of the foregoing equations it can be shown that

$$\frac{T}{T_\infty}=1-\frac{\gamma-1}{2}M_\infty^2\left[\left(\frac{V}{V_\infty}\right)^2-1\right] \quad \text{[adiab, perf]} \qquad (37)$$

$$\frac{p}{p_\infty}=\left\{1-\frac{\gamma-1}{2}M_\infty^2\left[\left(\frac{V}{V_\infty}\right)^2-1\right]\right\}^{\frac{\gamma}{\gamma-1}} \quad \text{[isen, perf]} \qquad (38)$$

$$\frac{\rho}{\rho_\infty}=\left\{1-\frac{\gamma-1}{2}M_\infty^2\left[\left(\frac{V}{V_\infty}\right)^2-1\right]\right\}^{\frac{1}{\gamma-1}} \quad \text{[isen perf]} \qquad (39)$$

In small-disturbance theory, where it is assumed that $(V-V_\infty)\ll V_\infty$, these equations take on the simplified form

$$\frac{T}{T_\infty}\cong 1-(\gamma-1)M_\infty^2\frac{V-V_\infty}{V_\infty} \quad \text{[adiab, perf]} \qquad (40)$$

$$\frac{p}{p_\infty}\cong 1-\gamma M_\infty^2\frac{V-V_\infty}{V_\infty} \quad \text{[isen, perf]} \qquad (41)$$

$$\frac{\rho}{\rho_\infty}\cong 1-M_\infty^2\frac{V-V_\infty}{V_\infty} \quad \text{[isen, perf]} \qquad (42)$$

USEFUL RATIOS

On the basis of the above results, useful relations can be derived expressing various dimensionless ratios as functions of a single parameter. These relations are given below grouped according to which of the various parameters (M, V/a_*, V/a_t, or V/V_m) is used as the independent variable. In each case the second form of the equation applies for $\gamma=\frac{7}{5}$.

Parameter M.—

$$\frac{T}{T_t}=\left(1+\frac{\gamma-1}{2}M^2\right)^{-1}=\left(1+\frac{M^2}{5}\right)^{-1} \quad \text{[adiab, perf]} \qquad (43)$$

$$\frac{p}{p_t}=\left(1+\frac{\gamma-1}{2}M^2\right)^{-\frac{\gamma}{\gamma-1}}=\left(1+\frac{M^2}{5}\right)^{-\frac{7}{2}} \quad \text{[isen, perf]} \qquad (44)$$

$$\frac{\rho}{\rho_t}=\left(1+\frac{\gamma-1}{2}M^2\right)^{-\frac{1}{\gamma-1}}=\left(1+\frac{M^2}{5}\right)^{-\frac{5}{2}} \quad \text{[isen, perf]} \qquad (45)$$

$$\frac{a}{a_t}=\left(1+\frac{\gamma-1}{2}M^2\right)^{-\frac{1}{2}}=\left(1+\frac{M^2}{5}\right)^{-\frac{1}{2}} \quad \text{[adiab, perf]} \qquad (46)$$

$$\frac{q}{p}=\frac{\gamma}{2}M^2=\frac{7}{10}M^2 \quad \text{[therm perf]} \tag{47}$$

$$\frac{q}{p_t}=\frac{\gamma}{2}M^2\left(1+\frac{\gamma-1}{2}M^2\right)^{-\frac{\gamma}{\gamma-1}}$$

$$=\frac{7}{10}M^2\left(1+\frac{M^2}{5}\right)^{-\frac{7}{2}} \quad \text{[isen, perf]} \tag{48}$$

$$\left(\frac{V}{a_t}\right)^2=M^2\left(1+\frac{\gamma-1}{2}M^2\right)^{-1}$$

$$=M^2\left(1+\frac{M^2}{5}\right)^{-1} \quad \text{[adiab, perf]} \tag{49}$$

$$\left(\frac{V}{a_*}\right)^2=\frac{\gamma+1}{2}M^2\left(1+\frac{\gamma-1}{2}M^2\right)^{-1}$$

$$=\frac{6M^2}{5}\left(1+\frac{M^2}{5}\right)^{-1} \quad \text{[adiab, perf]} \tag{50}$$

$$\left(\frac{V}{V_m}\right)^2=\frac{\gamma-1}{2}M^2\left(1+\frac{\gamma-1}{2}M^2\right)^{-1}$$

$$=\frac{M^2}{5}\left(1+\frac{M^2}{5}\right)^{-1} \quad \text{[adiab, perf]} \tag{51}$$

Parameter $\frac{V}{a_*}$.—

$$\frac{T}{T_t}=1-\frac{\gamma-1}{\gamma+1}\left(\frac{V}{a_*}\right)^2=1-\frac{1}{6}\left(\frac{V}{a_*}\right)^2 \quad \text{[adiab, perf]} \tag{52}$$

$$\frac{p}{p_t}=\left[1-\frac{\gamma-1}{\gamma+1}\left(\frac{V}{a_*}\right)^2\right]^{\frac{\gamma}{\gamma-1}}$$

$$=\left[1-\frac{1}{6}\left(\frac{V}{a_*}\right)^2\right]^{\frac{7}{2}} \quad \text{[isen, perf]} \tag{53}$$

$$\frac{\rho}{\rho_t}=\left[1-\frac{\gamma-1}{\gamma+1}\left(\frac{V}{a_*}\right)^2\right]^{\frac{1}{\gamma-1}}$$

$$=\left[1-\frac{1}{6}\left(\frac{V}{a_*}\right)^2\right]^{\frac{5}{2}} \quad \text{[isen, perf]} \tag{54}$$

$$\frac{a}{a_t}=\left[1-\frac{\gamma-1}{\gamma+1}\left(\frac{V}{a_*}\right)^2\right]^{\frac{1}{2}}$$

$$=\left[1-\frac{1}{6}\left(\frac{V}{a_*}\right)^2\right]^{\frac{1}{2}} \quad \text{[adiab, perf]} \tag{55}$$

$$\frac{q}{p}=\frac{\gamma}{\gamma+1}\left(\frac{V}{a_*}\right)^2\left[1-\frac{\gamma-1}{\gamma+1}\left(\frac{V}{a_*}\right)^2\right]^{-1}$$

$$=\frac{7}{12}\left(\frac{V}{a_*}\right)^2\left[1-\frac{1}{6}\left(\frac{V}{a_*}\right)^2\right]^{-1} \quad \text{[adiab, perf]} \tag{56}$$

$$\frac{q}{p_t}=\frac{\gamma}{\gamma+1}\left(\frac{V}{a_*}\right)^2\left[1-\frac{\gamma-1}{\gamma+1}\left(\frac{V}{a_*}\right)^2\right]^{\frac{1}{\gamma-1}}$$

$$=\frac{7}{12}\left(\frac{V}{a_*}\right)^2\left[1-\frac{1}{6}\left(\frac{V}{a_*}\right)^2\right]^{\frac{5}{2}} \quad \text{[isen, perf]} \tag{57}$$

$$M^2=\frac{2}{\gamma+1}\left(\frac{V}{a_*}\right)^2\left[1-\frac{\gamma-1}{\gamma+1}\left(\frac{V}{a_*}\right)^2\right]^{-1}$$

$$=\frac{5}{6}\left(\frac{V}{a_*}\right)^2\left[1-\frac{1}{6}\left(\frac{V}{a_*}\right)^2\right]^{-1} \quad \text{[adiab, perf]} \tag{58}$$

$$\left(\frac{V}{a_t}\right)^2=\frac{2}{\gamma+1}\left(\frac{V}{a_*}\right)^2=\frac{5}{6}\left(\frac{V}{a_*}\right)^2 \quad \text{[adiab, perf]} \tag{59}$$

$$\left(\frac{V}{V_m}\right)^2=\frac{\gamma-1}{\gamma+1}\left(\frac{V}{a_*}\right)^2=\frac{1}{6}\left(\frac{V}{a_*}\right)^2 \quad \text{[adiab, perf]} \tag{60}$$

Parameter $\frac{V}{a_t}$.—

$$\frac{T}{T_t}=1-\frac{\gamma-1}{2}\left(\frac{V}{a_t}\right)^2=1-\frac{1}{5}\left(\frac{V}{a_t}\right)^2 \quad \text{[adiab, perf]} \tag{61}$$

$$\frac{p}{p_t}=\left[1-\frac{\gamma-1}{2}\left(\frac{V}{a_t}\right)^2\right]^{\frac{\gamma}{\gamma-1}}$$

$$=\left[1-\frac{1}{5}\left(\frac{V}{a_t}\right)^2\right]^{\frac{7}{2}} \quad \text{[isen, perf]} \tag{62}$$

$$\frac{\rho}{\rho_t}=\left[1-\frac{\gamma-1}{2}\left(\frac{V}{a_t}\right)^2\right]^{\frac{1}{\gamma-1}}$$

$$=\left[1-\frac{1}{5}\left(\frac{V}{a_t}\right)^2\right]^{\frac{5}{2}} \quad \text{[isen, perf]} \tag{63}$$

$$\frac{a}{a_t}=\left[1-\frac{\gamma-1}{2}\left(\frac{V}{a_t}\right)^2\right]^{\frac{1}{2}}$$

$$=\left[1-\frac{1}{5}\left(\frac{V}{a_t}\right)^2\right]^{\frac{1}{2}} \quad \text{[adiab, perf]} \tag{64}$$

$$\frac{q}{p}=\frac{\gamma}{2}\left(\frac{V}{a_t}\right)^2\left[1-\frac{\gamma-1}{2}\left(\frac{V}{a_t}\right)^2\right]^{-1}$$

$$=\frac{7}{10}\left(\frac{V}{a_t}\right)^2\left[1-\frac{1}{5}\left(\frac{V}{a_t}\right)^2\right]^{-1} \quad \text{[adiab, perf]} \tag{65}$$

$$\frac{q}{p_t}=\frac{\gamma}{2}\left(\frac{V}{a_t}\right)^2\left[1-\frac{\gamma-1}{2}\left(\frac{V}{a_t}\right)^2\right]^{\frac{1}{\gamma-1}}$$

$$=\frac{7}{10}\left(\frac{V}{a_t}\right)^2\left[1-\frac{1}{5}\left(\frac{V}{a_t}\right)^2\right]^{\frac{5}{2}} \quad \text{[isen, perf]} \tag{66}$$

$$M^2=\left(\frac{V}{a_t}\right)^2\left[1-\frac{\gamma-1}{2}\left(\frac{V}{a_t}\right)^2\right]^{-1}$$

$$=\left(\frac{V}{a_t}\right)^2\left[1-\frac{1}{5}\left(\frac{V}{a_t}\right)^2\right]^{-1} \quad \text{[adiab, perf]} \tag{67}$$

$$\left(\frac{V}{a_*}\right)^2=\frac{\gamma+1}{2}\left(\frac{V}{a_t}\right)^2=\frac{6}{5}\left(\frac{V}{a_t}\right)^2 \quad \text{[adiab, perf]} \tag{68}$$

$$\left(\frac{V}{V_m}\right)^2=\frac{\gamma-1}{2}\left(\frac{V}{a_t}\right)^2=\frac{1}{5}\left(\frac{V}{a_t}\right)^2 \quad \text{[adiab, perf]} \tag{69}$$

Parameter $\frac{V}{V_m}$.—

$$\frac{T}{T_t}=1-\left(\frac{V}{V_m}\right)^2 \quad \text{[adiab, perf]} \tag{70}$$

$$\frac{p}{p_t}=\left[1-\left(\frac{V}{V_m}\right)^2\right]^{\frac{\gamma}{\gamma-1}}=\left[1-\left(\frac{V}{V_m}\right)^2\right]^{\frac{7}{2}} \quad \text{[isen, perf]} \tag{71}$$

$$\frac{\rho}{\rho_t}=\left[1-\left(\frac{V}{V_m}\right)^2\right]^{\frac{1}{\gamma-1}}=\left[1-\left(\frac{V}{V_m}\right)^2\right]^{\frac{5}{2}} \quad \text{[isen, perf]} \tag{72}$$

$$\frac{a}{a_t}=\left[1-\left(\frac{V}{V_m}\right)^2\right]^{\frac{1}{2}} \quad \text{[adiab, perf]} \tag{73}$$

$$\frac{q}{p}=\frac{\gamma}{\gamma-1}\left(\frac{V}{V_m}\right)^2\left[1-\left(\frac{V}{V_m}\right)^2\right]^{-1}=\frac{7}{2}\left(\frac{V}{V_m}\right)^2\left[1-\left(\frac{V}{V_m}\right)^2\right]^{-1} \quad \text{[adiab, perf]} \tag{74}$$

$$\frac{q}{p_t}=\frac{\gamma}{\gamma-1}\left(\frac{V}{V_m}\right)^2\left[1-\left(\frac{V}{V_m}\right)^2\right]^{\frac{1}{\gamma-1}}=\frac{7}{2}\left(\frac{V}{V_m}\right)^2\left[1-\left(\frac{V}{V_m}\right)^2\right]^{\frac{5}{2}} \quad \text{[isen, perf]} \tag{75}$$

$$M^2=\frac{2}{\gamma+1}\left(\frac{V}{V_m}\right)^2\left[1-\left(\frac{V}{V_m}\right)^2\right]^{-1}=\frac{5}{6}\left(\frac{V}{V_m}\right)^2\left[1-\left(\frac{V}{V_m}\right)^2\right]^{-1} \quad \text{[adiab, perf]} \tag{76}$$

$$\left(\frac{V}{a_t}\right)^2=\frac{2}{\gamma-1}\left(\frac{V}{V_m}\right)^2=5\left(\frac{V}{V_m}\right)^2 \quad \text{[adiab, perf]} \tag{77}$$

$$\left(\frac{V}{a_*}\right)^2=\frac{\gamma+1}{\gamma-1}\left(\frac{V}{V_m}\right)^2=6\left(\frac{V}{V_m}\right)^2 \quad \text{[adiab, perf]} \tag{78}$$

Tables I and II list numerical values of the following ratios with Mach number M as the independent variable:

$$\frac{p}{p_t}, \frac{\rho}{\rho_t}, \frac{T}{T_t}, \frac{q}{p_t}, \frac{V}{a_*}$$

STREAM-TUBE-AREA RELATIONS

If it is assumed that the density and speed are uniform across any section of a given stream tube, then the equation of continuity is

$$\rho VA=\text{constant}=\rho_* a_* A_* \tag{79}$$

By combining this and certain of the foregoing equations, the area ratio A_*/A can be expressed as a function of any one of the four parameters used above. The final equations are

$$\frac{A_*}{A}=\left(\frac{\gamma+1}{2}\right)^{\frac{\gamma+1}{2(\gamma-1)}} M\left(1+\frac{\gamma-1}{2}M^2\right)^{-\frac{\gamma+1}{2(\gamma-1)}}=\frac{216}{125}M\left(1+\frac{M^2}{5}\right)^{-3} \quad \text{[isen, perf]} \tag{80}$$

$$\frac{A_*}{A}=\left(\frac{\gamma+1}{2}\right)^{\frac{1}{\gamma-1}}\left(\frac{V}{a_*}\right)\left[1-\frac{\gamma-1}{\gamma+1}\left(\frac{V}{a_*}\right)^2\right]^{\frac{1}{\gamma-1}}=\left(\frac{6}{5}\right)^{\frac{5}{2}}\left(\frac{V}{a_*}\right)\left[1-\frac{1}{6}\left(\frac{V}{a_*}\right)^2\right]^{\frac{5}{2}} \quad \text{[isen, perf]} \tag{81}$$

$$\frac{A_*}{A}=\left(\frac{\gamma+1}{2}\right)^{\frac{\gamma+1}{2(\gamma-1)}}\left(\frac{V}{a_t}\right)\left[1-\frac{\gamma-1}{2}\left(\frac{V}{a_t}\right)^2\right]^{\frac{1}{\gamma-1}}=\frac{216}{125}\left(\frac{V}{a_t}\right)\left[1-\frac{1}{5}\left(\frac{V}{a_t}\right)^2\right]^{\frac{5}{2}} \quad \text{[isen, perf]} \tag{82}$$

$$\frac{A_*}{A}=\left(\frac{2}{\gamma-1}\right)^{\frac{1}{2}}\left(\frac{\gamma+1}{2}\right)^{\frac{\gamma+1}{2(\gamma-1)}}\left(\frac{V}{V_m}\right)\left[1-\left(\frac{V}{V_m}\right)^2\right]^{\frac{1}{\gamma-1}}=5^{\frac{1}{2}}\left(\frac{216}{125}\right)\left(\frac{V}{V_m}\right)\left[1-\left(\frac{V}{V_m}\right)^2\right]^{\frac{5}{2}} \quad \text{[isen, perf]} \tag{83}$$

Numerical values of A_*/A as a function of M are given in tables I and II.

Equation (79) combined with equations (26), (29b), (45) and (46) can be employed to obtain the mass-flow rate per unit area ρV along a stream tube as a function of Mach number, total temperature, and total pressure. Numerical values can be obtained conveniently from chart 1 where the variation with Mach number of the mass-flow rate per unit cross-sectional area is presented for various total temperatures and a total pressure of 1 pound per square inch absolute.

SHOCK WAVES

NORMAL SHOCK WAVES

BASIC EQUATIONS

The previous relations for isentropic flow are valid on either side of a shock wave, but not across it, because at the shock wave the flow quantities have discontinuities. Jump

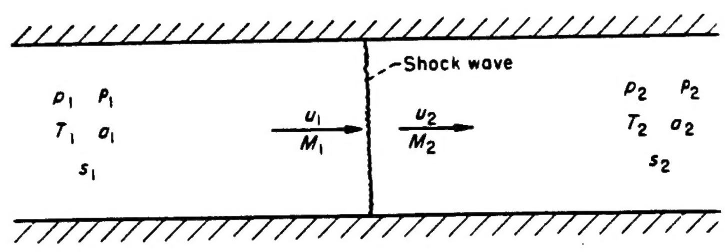

FIGURE 1.—Notation for normal shock wave.

conditions for a steady normal shock wave (fig. 1) result from requiring conservation of

mass: $\rho_1 u_1=\rho_2 u_2$ (84)

momentum: $p_1+\rho_1 u_1^2=p_2+\rho_2 u_2^2$ (85)

energy:[3] $\frac{1}{2}u_1^2+h_1=\frac{1}{2}u_2^2+h_2$ [adiab]

[3] The actual relation for conservation of energy is $\rho_1 u_1\left(\frac{1}{2}u_1^2+h_1\right)=\rho_2 u_2\left(\frac{1}{2}u_2^2+h_2\right)$; reduces to the above form in view of equation (84).

$$\left.\begin{aligned}\frac{1}{2}u_1^2+c_pT_1&=\frac{1}{2}u_2^2+c_pT_2\\ \frac{1}{2}u_1^2+\frac{\gamma}{\gamma-1}\frac{p_1}{\rho_1}&=\frac{1}{2}u_2^2+\frac{\gamma}{\gamma-1}\frac{p_2}{\rho_2}\\ \frac{1}{2}u_1^2+\frac{1}{\gamma-1}a_1^2&=\frac{1}{2}u_2^2+\frac{1}{\gamma-1}a_2^2\end{aligned}\right\}\text{[adiab, perf]}\quad(86b)$$

together with the requirement that the entropy does not decrease:

$$\Delta s\equiv s_2-s_1\geq 0 \qquad (87)$$

It follows immediately from the energy relation (86) that total enthalpy, total temperature, and total speed of sound are constant across the shock and hence (from the previous relations (33) for adiabatic flow) also the critical speed of sound and limiting speed:

$$h_{t_1}=h_{t_2}\quad\text{[adiab]} \qquad (88a)$$

$$\left.\begin{aligned}T_{t_1}&=T_{t_2}\\ a_{t_1}&=a_{t_2}\\ a_{*_1}&=a_{*_2}\\ V_{m_1}&=V_{m_2}\end{aligned}\right\}\text{[adiab, perf]} \qquad (88b)$$

Combining equations (84) to (86) leads to Prandtl's ...tion

$$u_1u_2=a_*^2=\frac{p_2-p_1}{\rho_2-\rho_1}\quad\text{[adiab, perf]} \qquad (89)$$

which implies that the flow is supersonic ahead of the shock wave and subsonic behind (the reverse possibility is ruled out by the requirement of nondecreasing entropy), and to the Rankine-Hugoniot relations

$$\frac{p_2}{p_1}=\frac{(\gamma+1)\rho_2-(\gamma-1)\rho_1}{(\gamma+1)\rho_1-(\gamma-1)\rho_2}\quad\text{[adiab, perf]} \qquad (90)$$

$$\frac{\rho_2}{\rho_1}=\frac{(\gamma+1)p_2+(\gamma-1)p_1}{(\gamma+1)p_1+(\gamma-1)p_2}\quad\text{[adiab, perf]} \qquad (91)$$

$$\frac{p_2-p_1}{\rho_2-\rho_1}=\gamma\frac{p_2+p_1}{\rho_2+\rho_1}\quad\text{[adiab, perf]} \qquad (92)$$

USEFUL RELATIONS

Many relations for normal shock waves are conveniently expressed in terms of either upstream Mach number M_1 or the static-pressure ratio across the shock $\xi\equiv p_2/p_1$. The following relations apply to adiabatic flow of a completely perfect fluid. The last form of each equation holds for $\gamma=7/5$.

...rameter M_1.—

$$\frac{p_2}{p_1}\equiv\xi=\frac{2\gamma M_1^2-(\gamma-1)}{\gamma+1}=\frac{7M_1^2-1}{6} \qquad (93)$$

$$\frac{\rho_2}{\rho_1}=\frac{u_1}{u_2}=\frac{u_1^2}{a_*^2}=\frac{a_*^2}{u_2^2}=\frac{(\gamma+1)M_1^2}{(\gamma-1)M_1^2+2}=\frac{6M_1^2}{M_1^2+5} \qquad (94)$$

$$\frac{T_2}{T_1}=\frac{a_2^2}{a_1^2}=\frac{[2\gamma M_1^2-(\gamma-1)][(\gamma-1)M_1^2+2]}{(\gamma+1)^2M_1^2}=\frac{(7M_1^2-1)(M_1^2+5)}{36M_1^2} \qquad (95)$$

$$M_2^2=\frac{(\gamma-1)M_1^2+2}{2\gamma M_1^2-(\gamma-1)}=\frac{M_1^2+5}{7M_1^2-1} \qquad (96)$$

$$\frac{p_2}{p_{t_1}}=\frac{2\gamma M_1^2-(\gamma-1)}{\gamma+1}\left[\frac{2}{(\gamma-1)M_1^2+2}\right]^{\frac{\gamma}{\gamma-1}}=\frac{7M_1^2-1}{6}\left(\frac{5}{M_1^2+5}\right)^{\frac{7}{2}} \qquad (97)$$

$$\frac{p_2}{p_{t_2}}=\left[\frac{4\gamma M_1^2-2(\gamma-1)}{(\gamma+1)^2M_1^2}\right]^{\frac{\gamma}{\gamma-1}}=\left[\frac{5(7M_1^2-1)}{36M_1^2}\right]^{\frac{7}{2}} \qquad (98)$$

$$\frac{p_{t_2}}{p_{t_1}}=\frac{\rho_{t_2}}{\rho_{t_1}}=e^{-\frac{\Delta s}{R}}=\left[\frac{(\gamma+1)M_1^2}{(\gamma-1)M_1^2+2}\right]^{\frac{\gamma}{\gamma-1}}\left[\frac{\gamma+1}{2\gamma M_1^2-(\gamma-1)}\right]^{\frac{1}{\gamma-1}}=\left(\frac{6M_1^2}{M_1^2+5}\right)^{\frac{7}{2}}\left(\frac{6}{7M_1^2-1}\right)^{\frac{5}{2}} \qquad (99)$$

$$\frac{p_{t_2}}{p_1}=\left[\frac{(\gamma+1)M_1^2}{2}\right]^{\frac{\gamma}{\gamma-1}}\left[\frac{\gamma+1}{2\gamma M_1^2-(\gamma-1)}\right]^{\frac{1}{\gamma-1}}=\left(\frac{6M_1^2}{5}\right)^{\frac{7}{2}}\left(\frac{6}{7M_1^2-1}\right)^{\frac{5}{2}} \qquad (100)$$

(Rayleigh pitot formula)

$$\begin{aligned}\frac{\Delta s}{c_v}&=(\gamma-1)\frac{\Delta s}{R}=-(\gamma-1)\ln\left(\frac{p_{t_2}}{p_{t_1}}\right)\\ &=\ln\left[\frac{2\gamma M_1^2-(\gamma-1)}{\gamma+1}\right]-\gamma\ln\left[\frac{(\gamma+1)M_1^2}{(\gamma-1)M_1^2+2}\right]\\ &=\ln\left(\frac{7M_1^2-1}{6}\right)-\frac{7}{5}\ln\left(\frac{6M_1^2}{M_1^2+5}\right)\end{aligned} \qquad (101)$$

$$\frac{p_2-p_1}{q_1}=\frac{4(M_1^2-1)}{(\gamma+1)M_1^2}=\frac{5(M_1^2-1)}{3M_1^2} \qquad (102)$$

Numerical values from equations (93), (94), (95), (96), (99), and (100) (with $\gamma=7/5$) are given in table II.

For weak shock waves (M_1 only slightly greater than unity) the following series are useful:

$$\frac{p_{t_2}}{p_{t_1}}=1-\frac{2\gamma}{3(\gamma+1)^2}(M_1^2-1)^3+\frac{2\gamma^2}{(\gamma+1)^3}(M_1^2-1)^4+\cdots=1-\frac{35}{216}(M_1^2-1)^3+\frac{245}{864}(M_1^2-1)^4+\cdots \qquad (103)$$

$$\frac{\Delta s}{R}=\frac{1}{\gamma-1}\frac{\Delta s}{c_v}=\frac{2\gamma}{3(\gamma+1)^2}(M_1^2-1)^3-\frac{2\gamma^2}{(\gamma+1)^3}(M_1^2-1)^4+\cdots=\frac{35}{216}(M_1^2-1)^3-\frac{245}{864}(M_1^2-1)^4+\cdots \qquad (104)$$

Parameter $\xi \equiv p_2/p_1$.—

$$M_1^2=\frac{(\gamma+1)\xi+(\gamma-1)}{2\gamma}=\frac{6\xi+1}{7} \tag{105}$$

$$\frac{\rho_2}{\rho_1}=\frac{u_1}{u_2}=\frac{(\gamma+1)\xi+(\gamma-1)}{(\gamma-1)\xi+(\gamma+1)}=\frac{6\xi+1}{\xi+6} \tag{106}$$

$$\frac{T_2}{T_1}=\frac{a_2^2}{a_1^2}=\xi\,\frac{(\gamma-1)\xi+(\gamma+1)}{(\gamma+1)\xi+(\gamma-1)}=\xi\,\frac{\xi+6}{6\xi+1} \tag{107}$$

$$M_2^2=\frac{(\gamma-1)\xi+(\gamma+1)}{2\gamma\xi}=\frac{\xi+6}{7\xi} \tag{108}$$

$$\frac{p_2}{p_{t_1}}=\xi\,\frac{p_1}{p_{t_1}}=\xi\left\{\frac{4\gamma}{(\gamma+1)[(\gamma-1)\xi+(\gamma+1)]}\right\}^{\frac{\gamma}{\gamma-1}}=\xi\left[\frac{35}{6(\xi+6)}\right]^{\frac{7}{2}} \tag{109}$$

$$\frac{p_2}{p_{t_2}}=\xi\,\frac{p_1}{p_{t_2}}=\left\{\frac{4\gamma\xi}{(\gamma+1)[(\gamma+1)\xi+(\gamma-1)]}\right\}^{\frac{\gamma}{\gamma-1}}=\left[\frac{35\xi}{6(6\xi+1)}\right]^{\frac{7}{2}} \tag{110}$$

$$\frac{p_{t_2}}{p_{t_1}}=\frac{\rho_{t_2}}{\rho_{t_1}}=e^{-\frac{\Delta s}{R}}=\xi^{-\frac{1}{\gamma-1}}\left[\frac{(\gamma+1)\xi+(\gamma-1)}{(\gamma-1)\xi+(\gamma+1)}\right]^{\frac{\gamma}{\gamma-1}}$$

$$=\left(\frac{1}{\xi}\right)^{\frac{5}{2}}\left(\frac{6\xi+1}{\xi+6}\right)^{\frac{7}{2}} \tag{111}$$

$$\frac{\Delta s}{c_v}=(\gamma-1)\,\frac{\Delta s}{R}=-(\gamma-1)\ln\left(\frac{p_{t_2}}{p_{t_1}}\right)=\ln\xi-$$

$$\gamma\ln\left[\frac{(\gamma+1)\xi+(\gamma-1)}{(\gamma-1)\xi+(\gamma+1)}\right]=\ln\xi-\frac{7}{5}\ln\left(\frac{6\xi+1}{\xi+6}\right) \tag{112}$$

For weak shock waves (ξ only slightly greater than unity)

$$\frac{p_{t_2}}{p_{t_1}}=1-\frac{\gamma+1}{12\gamma^2}\,(\xi-1)^3+\frac{\gamma+1}{8\gamma^2}\,(\xi-1)^4+\cdots$$

$$=1-\frac{5}{49}\,(\xi-1)^3+\frac{15}{98}\,(\xi-1)^4+\cdots \tag{113}$$

$$\frac{\Delta s}{R}=\frac{1}{\gamma-1}\,\frac{\Delta s}{c_v}=\frac{\gamma+1}{12\gamma^2}\,(\xi-1)^3-\frac{\gamma+1}{8\gamma^2}\,(\xi-1)^4+\cdots$$

$$=\frac{5}{49}\,(\xi-1)^3-\frac{15}{98}\,(\xi-1)^4+\cdots \tag{114}$$

In unsteady flow a normal shock wave acts at each instant as a steady shock. Hence all the above relations are valid across a moving normal shock wave if instantaneous velocities are measured relative to the shock.

OBLIQUE SHOCK WAVES

In general, a three-dimensional shock wave will be curved, and will separate two regions of nonuniform flow. However, the shock transition at each point takes place instantaneously, so that it is sufficient to consider an arbitrarily small neighborhood of the point. In such a neighborhood

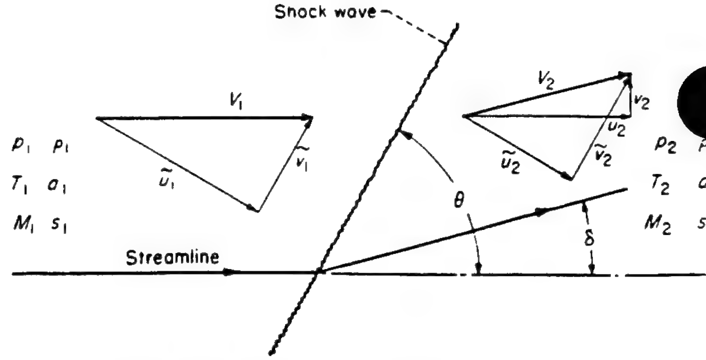

FIGURE 2.—Notation for oblique shock wave.

the shock wave may be regarded as plane to any desire degree of accuracy, and the flows on either side as uniforr and parallel. Moreover, with the proper orientation o axes the flow is locally two-dimensional. Hence it i sufficient to consider a straight oblique shock wave in uniform parallel two-dimensional stream, as shown in figure 2

BASIC EQUATIONS

For a steady oblique shock wave, jump conditions resul from requiring conservation of

mass: $\rho_1\tilde{u}_1=\rho_2\tilde{u}_2$ (115

normal momentum: $p_1+\rho_1\tilde{u}_1^2=p_2+\rho_2\tilde{u}_2^2$ (116

tangential momentum: $\rho_1\tilde{u}_1\tilde{v}_1=\rho_2\tilde{u}_2\tilde{v}_2$ (

energy[4]: $\frac{1}{2}\,(\tilde{u}_1^2+\tilde{v}_1^2)+h_1=\frac{1}{2}\,(\tilde{u}_2^2+\tilde{v}_2^2)+h_2$ [adiab] (11

$$\left.\begin{aligned}&\frac{1}{2}\,(\tilde{u}_1^2+\tilde{v}_1^2)+c_pT_1=\frac{1}{2}\,(\tilde{u}_2^2+\tilde{v}_2^2)+c_pT_2\\&\frac{1}{2}\,(\tilde{u}_1^2+\tilde{v}_1^2)+\frac{\gamma}{\gamma-1}\,\frac{p_1}{\rho_1}=\frac{1}{2}\,(\tilde{u}_2^2+\tilde{v}_2^2)+\frac{\gamma}{\gamma-1}\,\frac{p_2}{\rho_2}\\&\frac{1}{2}\,(\tilde{u}_1^2+\tilde{v}_1^2)+\frac{1}{\gamma-1}\,a_1^2=\frac{1}{2}\,(\tilde{u}_2^2+\tilde{v}_2^2)+\frac{1}{\gamma-1}\,a_2^2\end{aligned}\right\}\begin{bmatrix}\text{adiab,}\\\text{perf}\end{bmatrix}$$

(118b

together with the requirement that the entropy does no decrease:

$$\Delta s\equiv s_2-s_1\geqq 0$$ (11

Again it follows from the energy relation (118) that tot enthalpy, total temperature, and total speed of sound ar constant across the shock and hence also the critical spee of sound and limiting speed:

$$h_{t_1}=h_{t_2}\quad\text{[adiab]}$$ (12

$$\left.\begin{aligned}T_{t_1}&=T_{t_2}\\a_{t_1}&=a_{t_2}\\a_{*_1}&=a_{*_2}\\V_{m_1}&=V_{m_2}\end{aligned}\right\}\begin{bmatrix}\text{adiab,}\\\text{perf}\end{bmatrix}$$ (

[4] Compare remark for normal shock waves, footnote on page 6.

CONNECTION WITH NORMAL SHOCK

comparison of equation (115) with (117) shows that ngential velocity is constant across the shock wave:

$$\tilde{v}_1=\tilde{v}_2 \quad \text{[adiab]} \tag{122}$$

so that the change in velocity is normal to the shock. It follows that

$$\frac{1}{2}\,\tilde{v}_1^2=\frac{1}{2}\,\tilde{v}_2^2$$

so that the energy equation (118a) reduces to

$$\frac{1}{2}\,\tilde{u}_1^2+h_1=\frac{1}{2}\,\tilde{u}_2^2+h_2 \quad \text{[adiab]} \tag{123}$$

Now equations (115), (116), and (123) involve only the component of velocity $\tilde{u}$ normal to the shock, and are identical with equations (84), (85), and (86) for normal shock waves. Hence an oblique shock wave acts as a normal shock to the component of flow perpendicular to it, while the tangential component is unchanged. This is also clear physically from the "sweepback principle" that the oblique flow is reduced to the normal flow by a uniform translation of axes (Galilean transformation).

Because the speed of sound depends on the tangential velocity, Prandtl's relation differs from that for normal shock waves (see ref. 11, pp. 302–303):

$$\tilde{u}_1\tilde{u}_2=a_*^2-\frac{\gamma-1}{\gamma+1}\,\tilde{v}^2 \quad \text{[adiab, perf]} \tag{124}$$

where a_* and $\tilde{v}$ can be evaluated on either side of the shock.

The Rankine-Hugoniot relations are the same as for normal shock waves:

$$\frac{p_2}{p_1}=\frac{(\gamma+1)\rho_2-(\gamma-1)\rho_1}{(\gamma+1)\rho_1-(\gamma-1)\rho_2} \quad \text{[adiab, perf]} \tag{125}$$

$$\frac{\rho_2}{\rho_1}=\frac{(\gamma+1)p_2+(\gamma-1)p_1}{(\gamma+1)p_1+(\gamma-1)p_2} \quad \text{[adiab, perf]} \tag{126}$$

$$\frac{p_2-p_1}{\rho_2-\rho_1}=\gamma\,\frac{p_2+p_1}{\rho_2+\rho_1} \quad \text{[adiab, perf]} \tag{127}$$

USEFUL RELATIONS

Because an oblique shock wave acts as a normal shock to the flow perpendicular to it, the previous relations for normal shocks (except those for ratios of static to total pressures) apply to oblique shocks if M_1 and M_2 are replaced by their normal components $M_1 \sin\theta$ and $M_2 \sin(\theta-\delta)$. This gives most of the following relations; the remainder are derived from them by using the kinematic condition that the stream turns through an angle δ, together with the vious isentropic-flow relations.

meters M_1 and θ.—

$$\frac{p_2}{p_1}\equiv\xi=\frac{2\gamma M_1^2\sin^2\theta-(\gamma-1)}{\gamma+1}=\frac{7M_1^2\sin^2\theta-1}{6} \tag{128}$$

$$\frac{\rho_2}{\rho_1}=\frac{\tilde{u}_1}{\tilde{u}_2}=\frac{(\gamma+1)M_1^2\sin^2\theta}{(\gamma-1)M_1^2\sin^2\theta+2}=\frac{6M_1^2\sin^2\theta}{M_1^2\sin^2\theta+5} \tag{129}$$

$$\frac{T_2}{T_1}=\frac{a_2^2}{a_1^2}=\frac{[2\gamma M_1^2\sin^2\theta-(\gamma-1)][(\gamma-1)M_1^2\sin^2\theta+2]}{(\gamma+1)^2M_1^2\sin^2\theta}$$
$$=\frac{(7M_1^2\sin^2\theta-1)(M_1^2\sin^2\theta+5)}{36M_1^2\sin^2\theta} \tag{130}$$

$$M_2^2\sin^2(\theta-\delta)=\frac{(\gamma-1)M_1^2\sin^2\theta+2}{2\gamma M_1^2\sin^2\theta-(\gamma-1)}=\frac{M_1^2\sin^2\theta+5}{7M_1^2\sin^2\theta-1} \tag{131}$$

$$M_2^2=\frac{(\gamma+1)^2M_1^4\sin^2\theta-4(M_1^2\sin^2\theta-1)(\gamma M_1^2\sin^2\theta+1)}{[2\gamma M_1^2\sin^2\theta-(\gamma-1)][(\gamma-1)M_1^2\sin^2\theta+2]}$$
$$=\frac{36M_1^4\sin^2\theta-5(M_1^2\sin^2\theta-1)(7M_1^2\sin^2\theta+5)}{(7M_1^2\sin^2\theta-1)(M_1^2\sin^2\theta+5)} \tag{132}$$

$$\frac{\tilde{u}_2}{V_1}=\frac{(\gamma-1)M_1^2\sin^2\theta+2}{(\gamma+1)M_1^2\sin^2\theta}\sin\theta=\frac{M_1^2\sin^2\theta+5}{6M_1^2\sin^2\theta}\sin\theta \tag{133}$$

$$\frac{\tilde{v}_2}{V_1}=\frac{\tilde{v}_1}{V_1}=\cos\theta \tag{134}$$

$$\frac{u_2}{V_1}=1-\frac{2(M_1^2\sin^2\theta-1)}{(\gamma+1)M_1^2}=1-\frac{5(M_1^2\sin^2\theta-1)}{6M_1^2} \tag{135}$$

$$\frac{v_2}{V_1}=\frac{2(M_1^2\sin^2\theta-1)}{(\gamma+1)M_1^2}\cot\theta=\frac{5(M_1^2\sin^2\theta-1)}{6M_1^2}\cot\theta \tag{136}$$

$$\frac{V_2^2}{V_1^2}=1-4\,\frac{(M_1^2\sin^2\theta-1)(\gamma M_1^2\sin^2\theta+1)}{(\gamma+1)^2M_1^4\sin^2\theta}$$
$$=1-\frac{5}{36}\,\frac{(M_1^2\sin^2\theta-1)(7M_1^2\sin^2\theta+5)}{M_1^4\sin^2\theta} \tag{137}$$

$$\cot\delta=\tan\theta\left[\frac{(\gamma+1)M_1^2}{2(M_1^2\sin^2\theta-1)}-1\right]$$
$$=\tan\theta\left[\frac{6M_1^2}{5(M_1^2\sin^2\theta-1)}-1\right] \tag{138}$$

$$\tan\delta=\frac{2\cot\theta(M_1^2\sin^2\theta-1)}{2+M_1^2(\gamma+1-2\sin^2\theta)}=\frac{5\cot\theta(M_1^2\sin^2\theta-1)}{5+M_1^2(6-5\sin^2\theta)} \tag{139a}$$

$$=\frac{M_1^2\sin 2\theta-2\cot\theta}{2+M_1^2(\gamma+\cos 2\theta)}=5\,\frac{M_1^2\sin 2\theta-2\cot\theta}{10+M_1^2(7+5\cos 2\theta)} \tag{139b}$$

$$\frac{p_2}{p_{t_1}}=\frac{2\gamma M_1^2\sin^2\theta-(\gamma-1)}{(\gamma+1)}\left[\frac{2}{(\gamma-1)M_1^2+2}\right]^{\frac{\gamma}{\gamma-1}}$$
$$=\frac{7M_1^2\sin^2\theta-1}{6}\left(\frac{5}{M_1^2+5}\right)^{7/2} \tag{140}$$

$$\frac{p_2}{p_{t_2}}=\left\{2\frac{[2\gamma M_1^2\sin^2\theta-(\gamma-1)]\,[(\gamma-1)M_1^2\sin^2\theta+2]}{(\gamma+1)^2M_1^2\sin^2\theta\,[(\gamma-1)M_1^2+2]}\right\}^{\frac{\gamma}{\gamma-1}}$$
$$=\left[5\,\frac{(7M_1^2\sin^2\theta-1)\,(M_1^2\sin^2\theta+5)}{36M_1^2\sin^2\theta\,(M_1^2+5)}\right]^{7/2} \tag{141}$$

$$\frac{p_{t_2}}{p_{t_1}}=\frac{\rho_{t_2}}{\rho_{t_1}}=e^{-\frac{\Delta s}{R}}$$

$$=\left[\frac{(\gamma+1)M_1^2\sin^2\theta}{(\gamma-1)M_1^2\sin^2\theta+2}\right]^{\frac{\gamma}{\gamma-1}}\left[\frac{\gamma+1}{2\gamma M_1^2\sin^2\theta-(\gamma-1)}\right]^{\frac{1}{\gamma-1}}$$

$$=\left(\frac{6M_1^2\sin^2\theta}{M_1^2\sin^2\theta+5}\right)^{7/2}\left(\frac{6}{7M_1^2\sin^2\theta-1}\right)^{5/2} \tag{142}$$

$$\frac{p_{t_2}}{p_1}=\left[\frac{\gamma+1}{2\gamma M_1^2\sin^2\theta-(\gamma-1)}\right]^{\frac{1}{\gamma-1}}\times$$

$$\left\{\frac{(\gamma+1)M_1^2\sin^2\theta\,[(\gamma-1)M_1^2+2]}{2[(\gamma-1)M_1^2\sin^2\theta+2]}\right\}^{\frac{\gamma}{\gamma-1}}$$

$$=\left(\frac{6}{7M_1^2\sin^2\theta-1}\right)^{5/2}\left[\frac{6M_1^2\sin^2\theta(M_1^2+5)}{5(M_1^2\sin^2\theta+5)}\right]^{7/2} \tag{143}$$

$$\frac{\Delta s}{c_v}=(\gamma-1)\frac{\Delta s}{R}=-(\gamma-1)\ln\left(\frac{p_{t_2}}{p_{t_1}}\right)$$

$$=\ln\left[\frac{2\gamma M_1^2\sin^2\theta-(\gamma-1)}{\gamma+1}\right]-$$

$$\gamma\ln\left[\frac{(\gamma+1)M_1^2\sin^2\theta}{(\gamma-1)M_1^2\sin^2\theta+2}\right]$$

$$=\ln\left(\frac{7M_1^2\sin^2\theta-1}{6}\right)-\frac{7}{5}\ln\left(\frac{6M_1^2\sin^2\theta}{M_1^2\sin^2\theta+5}\right) \tag{144}$$

$$\frac{p_2-p_1}{q_1}=\frac{4(M_1^2\sin^2\theta-1)}{(\gamma+1)M_1^2}=\frac{5}{3}\,\frac{M_1^2\sin^2\theta-1}{M_1^2} \tag{145}$$

Values of the following ratios for oblique shock waves can be read from table II, provided $M_1\sin\theta$ is used instead of M_1 in the first column:

$$\frac{p_2}{p_1},\ \frac{\rho_2}{\rho_1},\ \frac{T_2}{T_1},\ \frac{p_{t_2}}{p_{t_1}}$$

For weak shock waves ($M_1\sin\theta$ only slightly greater than unity) the following series are obtained from equations (103) and (104) by replacing M_1 by $M_1\sin\theta$:

$$\frac{p_{t_2}}{p_{t_1}}=1-\frac{2\gamma}{3(\gamma+1)^2}(M_1^2\sin^2\theta-1)^3+\frac{2\gamma^2}{(\gamma+1)^3}(M_1^2\sin^2\theta-1)^4+\ldots$$

$$=1-\frac{35}{216}(M_1^2\sin^2\theta-1)^3+\frac{245}{864}(M_1^2\sin^2\theta-1)^4+\ldots \tag{146}$$

$$\frac{\Delta s}{R}=\frac{1}{\gamma-1}\,\frac{\Delta s}{c_v}=\frac{2\gamma}{3(\gamma+1)^2}(M_1^2\sin^2\theta-1)^3-$$

$$\frac{2\gamma^2}{(\gamma+1)^3}(M_1^2\sin^2\theta-1)^4+\ldots$$

$$=\frac{35}{216}(M_1^2\sin^2\theta-1)^3-\frac{245}{864}(M_1^2\sin^2\theta-1)^4+\ldots \tag{147}$$

Parameters θ and δ.—

$$\frac{1}{M_1^2}=\sin^2\theta-\frac{\gamma+1}{2}\,\frac{\sin\theta\sin\delta}{\cos(\theta-\delta)}=\sin^2\theta-\frac{\gamma+1}{2}\,\frac{\tan\delta}{\tan\delta+\cot\theta}$$

$$=\sin^2\theta-\frac{\gamma+1}{2}\,\frac{\tan\theta}{\tan\theta+\cot\delta} \tag{148a}$$

$$M_1^2=\frac{2(\cot\theta+\tan\delta)}{\sin 2\theta-\tan\delta(\gamma+\cos 2\theta)}$$

$$=\frac{10(\cot\theta+\tan\delta)}{5\sin 2\theta-\tan\delta\,(7+5\cos 2\theta)} \tag{148b}$$

$$\frac{p_2-p_1}{q_1}=2\,\frac{\sin\theta\sin\delta}{\cos(\theta-\delta)}$$

$$=2\,\frac{\tan\delta}{\tan\delta+\cot\theta}=2\,\frac{\tan\theta}{\tan\theta+\cot\delta} \tag{149a}$$

$$\frac{\rho_2-\rho_1}{\rho_2}=\frac{\sin\delta}{\sin\theta\cos(\theta-\delta)} \tag{149b}$$

Parameters M_1 and δ.—

No convenient explicit relations exist. However, the value of $\sin^2\theta$ can be found by solving the following cubic equation (ref. 12):

$$\sin^6\theta+b\sin^4\theta+c\sin^2\theta+d=0 \tag{150a}$$

where

$$\left.\begin{aligned} b&=-\frac{M_1^2+2}{M_1^2}-\gamma\sin^2\delta\\ c&=\frac{2M_1^2+1}{M_1^4}+\left[\frac{(\gamma+1)^2}{4}+\frac{\gamma-1}{M_1^2}\right]\sin^2\delta\\ d&=-\frac{\cos^2\delta}{M_1^4}\end{aligned}\right\} \tag{150b}$$

The smallest of the three roots corresponds to a decrease in entropy and should be disregarded.

For weak shock waves (small deflections δ) the following series are useful (note that δ must be measured in radians):

$$\frac{p_2}{p_1}=1+\frac{\gamma M_1^2}{(M_1^2-1)^{1/2}}\,\delta+\gamma M_1^2\,\frac{(\gamma+1)M_1^4-4(M_1^2-1)}{4(M_1^2-1)^2}\,\delta^2+$$

$$\frac{\gamma M_1^2}{(M_1^2-1)^{7/2}}\left[\frac{(\gamma+1)^2}{32}M_1^8-\frac{7+12\gamma-3\gamma^2}{24}M_1^6+\right.$$

$$\left.\frac{3}{4}(\gamma+1)M_1^4-M_1^2+\frac{2}{3}\right]\delta^3+\ldots \tag{151}$$

$$\frac{p_2-p_1}{q_1}=\frac{2}{(M_1^2-1)^{1/2}}\,\delta+\frac{(\gamma+1)M_1^4-4(M_1^2-1)}{2(M_1^2-1)^2}\,\delta^2+$$

$$\frac{1}{(M_1^2-1)^{7/2}}\left[\frac{(\gamma+1)^2}{16}M_1^8-\frac{7+12\gamma-3\gamma^2}{12}M_1^6+\right.$$

$$\left.\frac{3}{2}(\gamma+1)M_1^4-2M_1^2+\frac{4}{3}\right]\delta^3+\ldots$$

$$=1+\frac{M_1^2}{(M_1^2-1)^{1/2}}\,\delta+M_1^2\,\frac{(3-\gamma)M_1^2(M_1^2-2)+4}{4(M_1^2-1)^2}\,\delta^2+\ldots \tag{153}$$

$$\frac{T_2}{T_1}=1+\frac{(\gamma-1)M_1^2}{(M_1^2-1)^{1/2}}\,\delta+$$

$$(\gamma-1)M_1^2\,\frac{(\gamma+1)M_1^4-2(M_1^2+2)(M_1^2-1)}{4(M_1^2-1)^2}\,\delta^2+\ldots \tag{154}$$

Since flow through weak shock waves is nearly insentropic, compressions through small angles can also be calculated with the aid of table II by regarding them as reversed Prandtl-Meyer expansions (see later section). The resulting numerical accuracy is greater than that obtained by retaining terms up to δ^2 in the above series, and nearly equal to that obtained by retaining terms up to δ^3.

Charts 2, 3, and 4 show the variation of shock-wave angle, pressure coefficient across a shock wave, and downstream Mach number with flow-deflection angle for various upstream Mach numbers.

Parameter $\xi\equiv p_2/p_1$.—

$$M_1^2\sin^2\theta=\frac{(\gamma+1)\xi+(\gamma-1)}{2\gamma}=\frac{6\xi+1}{7} \tag{155}$$

$$M_2^2\sin^2(\theta-\delta)=\frac{(\gamma-1)\xi+(\gamma+1)}{2\gamma\xi}=\frac{\xi+6}{7\xi} \tag{156}$$

$$M_2^2=\frac{M_1^2[(\gamma+1)\xi+(\gamma-1)]-2(\xi^2-1)}{\xi[(\gamma-1)\xi+(\gamma+1)]}$$

$$=\frac{M_1^2(6\xi+1)-5(\xi^2-1)}{\xi(\xi+6)} \tag{157}$$

$$\frac{\rho_2}{\rho_1}=\frac{(\gamma+1)\xi+(\gamma-1)}{(\gamma-1)\xi+(\gamma+1)}=\frac{6\xi+1}{\xi+6} \tag{158}$$

$$\frac{T_2}{T_1}=\frac{a_2^2}{a_1^2}=\xi\,\frac{(\gamma-1)\xi+(\gamma+1)}{(\gamma+1)\xi+(\gamma-1)}=\xi\,\frac{\xi+6}{6\xi+1} \tag{159}$$

$$\tan^2\delta=\left(\frac{\xi-1}{\gamma M_1^2-\xi+1}\right)^2\frac{2\gamma M_1^2-(\gamma-1)-(\gamma+1)\xi}{(\gamma+1)\xi+(\gamma-1)}$$

$$=\left[\frac{5(\xi-1)}{7M_1^2-5(\xi-1)}\right]^2\frac{7M_1^2-(6\xi-1)}{6\xi+1} \tag{160}$$

$$\frac{p_{t_2}}{p_{t_1}}=\frac{\rho_{t_2}}{\rho_{t_1}}=e^{-\frac{\Delta s}{R}}=\left[\frac{(\gamma+1)\xi+(\gamma-1)}{(\gamma-1)\xi+(\gamma+1)}\right]^{\frac{\gamma}{\gamma-1}}\xi^{-\frac{1}{\gamma-1}}$$

$$=\left(\frac{6\xi+1}{\xi+6}\right)^{7/2}\xi^{-5/2} \tag{161}$$

$$\frac{V_2^2}{V_1^2}=1-\frac{2(\xi^2-1)}{M_1^2[(\gamma+1)\xi+(\gamma-1)]}=1-\frac{5(\xi^2-1)}{M_1^2(6\xi+1)} \tag{162}$$

For weak shock waves, equations (113) and (114) apply to oblique as well as normal shocks.

SHOCK POLAR

The velocities associated with an oblique shock wave are conveniently represented in the velocity-vector (hodograph) plane. For a given Mach number ahead of the shock wave, all possible velocity vectors behind the shock lie on a single curve.

Only the closed loop represents real shock waves with non-decreasing entropy, and forms Busemann's shock polar (fig. 3). Its equation is

$$v_2^2=(V_1-u_2)^2\,\frac{u_2-\dfrac{a_*^2}{V_1}}{\dfrac{2}{\gamma+1}V_1+\dfrac{a_*^2}{V_1}-u_2} \tag{163}$$

Other forms of this equation convenient for computation are, given V_1 and M_1,

$$\left(\frac{v_2}{V_1}\right)^2=\left(1-\frac{u_2}{V_1}\right)^2\frac{(M_1^2-1)-\dfrac{\gamma+1}{2}M_1^2\left(1-\dfrac{u_2}{V_1}\right)}{1+\dfrac{\gamma+1}{2}M_1^2\left(1-\dfrac{u_2}{V_1}\right)}$$

$$=\left(1-\frac{u_2}{V_1}\right)^2\frac{5(M_1^2-1)-6M_1^2\left(1-\dfrac{u_2}{V_1}\right)}{5+6M_1^2\left(1-\dfrac{u_2}{V_1}\right)} \tag{164a}$$

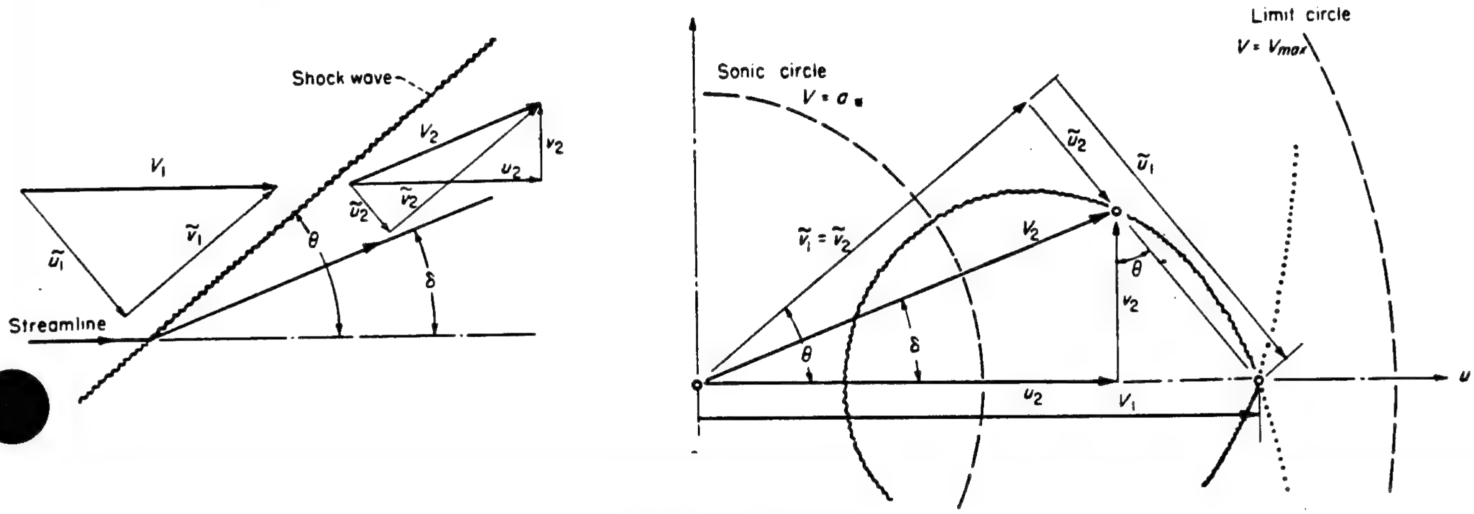

FIGURE 3.—Shock polar.

given a_* and V_1,

$$\left(\frac{V_2}{a_*}\right)^2=\left(\frac{V_1}{a_*}-\frac{u_2}{a_*}\right)^2\frac{\frac{V_1}{a_*}\frac{u_2}{a_*}-1}{1+\frac{2}{\gamma+1}\left(\frac{V_1}{a_*}\right)^2-\frac{V_1}{a_*}\frac{u_2}{a_*}}$$

$$=\left(\frac{V_1}{a_*}-\frac{u_2}{a_*}\right)^2\frac{6\left(\frac{V_1}{a_*}\frac{u_2}{a_*}-1\right)}{5\left(\frac{V_1}{a_*}\right)^2-6\left(\frac{V_1}{a_*}\frac{u_2}{a_*}-1\right)} \tag{164b}$$

and given V_1 and V_m,

$$\left(\frac{v_2}{V_m}\right)^2=\left(\frac{V_1}{V_m}-\frac{u_2}{V_m}\right)^2\frac{\frac{V_1}{V_m}\frac{u_2}{V_m}-\frac{\gamma-1}{\gamma+1}}{\frac{2}{\gamma+1}\left(\frac{V_1}{V_m}\right)^2+\frac{\gamma-1}{\gamma+1}-\frac{V_1}{V_m}\frac{u_2}{V_m}}$$

$$=\left(\frac{V_1}{V_m}-\frac{u_2}{V_m}\right)^2\frac{\left(6\frac{V_1}{V_m}\frac{u_2}{V_m}-1\right)}{5\left(\frac{V_1}{V_m}\right)^2-\left(6\frac{V_1}{V_m}\frac{u_2}{V_m}-1\right)} \tag{164c}$$

The shock-wave angle θ and wedge angle δ are given in terms of the velocity components by

$$\tan\theta=\frac{V_1-u_2}{v_2}=\frac{\bar{u}_1}{\bar{v}_1} \tag{165}$$

$$\tan\delta=\frac{v_2}{u_2} \tag{166}$$

The shock-wave angle θ_* for sonic flow behind the shock is found (by setting $M_2=1$ in eq. (132)) to be given by

$$\sin^2\theta_*=\frac{1}{4\gamma M_1^2}\{(\gamma+1)M_1^2-(3-\gamma)+\sqrt{(\gamma+1)[(\gamma+1)M_1^4-2(3-\gamma)M_1^2+(\gamma+9)]}\}$$

$$=\frac{1}{7M_1^2}[3M_1^2-2+\sqrt{3(3M_1^4-4M_1^2+13)}] \tag{167}$$

The shock-wave angle $\theta_{\delta_{max}}$ for maximum stream deflection behind the shock is given by

$$\sin^2\theta_{\delta_{max}}=\frac{1}{4\gamma M_1^2}\{(\gamma+1)M_1^2-4+\sqrt{(\gamma+1)[(\gamma+1)M_1^4+8(\gamma-1)M_1^2+16]}\}$$

$$=\frac{1}{7M_1^2}[3M_1^2-5+\sqrt{3(3M_1^4+4M_1^2+20)}] \tag{168}$$

For small deflection angles (hence Mach numbers close to unity), the deflection angle (radians) for sonic flow behind the shock is given approximately in terms of the upstream Mach number by

$$\delta_*=\frac{1}{\sqrt{2}(\gamma+1)}\frac{(M_1^2-1)^{3/2}}{M_1^2}=0.2946\frac{(M_1^2-1)^{3/2}}{M_1^2} \tag{169}$$

The maximum stream deflection angle for a specified upstream Mach number is given approximately by

$$\delta_{max}=\frac{4}{3\sqrt{3}(\gamma+1)}\frac{(M_1^2-1)^{3/2}}{M_1^2}=0.3208\frac{(M_1^2-1)^{3/2}}{M_1^2} \tag{170}$$

In unsteady flow all the above relations are valid across a moving oblique shock wave if instantaneous velocities are measured relative to the shock.

SUPERSONIC FLOW PAST WEDGES AND CONES

A shock wave forms ahead of any body in supersonic flight and remains fixed relative to the body if the flight is steady. It stands ahead of blunt shapes, but may be attached to pointed shapes.

Just at the tip of a pointed airfoil or body of revolution the flow is the same as for the initially tangent wedge or cone. The bow wave is attached at sufficiently high Mach numbers for a wedge of semivertex angle δ less than $\sin^{-1}(1/\gamma)=45.6°$ for $\gamma=7/5$, and for a circular cone of semivertex angle σ less than $57.5°$ for $\gamma=1.405$. Below these limits, the wave is attached above a minimum Mach number whose dependence upon nose angle is shown for wedges and cones in figure 4. (These values can be applied to pointed airfoils and bodies of revolution which are not concave.) Also shown in figure 4 are the slightly higher Mach numbers above which the velocity behind the shock wave is supersonic, and for the cone the still higher Mach number above which the flow is supersonic even at the surface. (For wedges these last two coincide.) For thin wedges, these Mach numbers are given approximately by equations (169) and (170).

FLOW PAST WEDGES

If the bow shock wave is attached to a wedge, it is straight and the flow behind the shock consists of uniform streams parallel to either face of the wedge. The flow pattern above the upper face (fig. 5) may be regarded as obtained from the straight oblique shock-wave pattern of figure 2 by replacing the streamline behind the shock wave with a solid wall. Flow quantities are determined by the oblique-shock-wave relations, equations (115) to (170). As noted previously, table II can also be applied if $M_1 \sin\theta$ is used in place of M_1 in the first column.

The flows above and below the wedge are independent, so that inclined wedges can be treated if neither face exceeds the attachment angle shown in figure 4. However, if the angle of attack exceeds the semivertex angle, the flow over the upper (leeward) surface is given by a Prandtl-Meyer expansion (see fig. 4) rather than by the shock relations.

It is clear from the shock polar (fig. 3) that two different shock waves and flow patterns are theoretically possible for a given wedge and Mach number. However, it is believed that only the weaker shock wave (larger u_2 and smaller θ) can occur attached to an isolated convex body.

Charts 2, 3, and 4 show the dependence of shock-wave angle, surface pressure coefficient, and downstream Mach number upon wedge angle for various free-stream Mach numbers.

FLOW PAST CONES

If the bow shock wave is attached to an uninclined circular cone, the shock wave too has the form of a circular cone. Flow quantities are constant on all concentric conical surfaces lying between the shock wave and the body, and so depend upon only one space variable. The transition across the shock wave is governed by the oblique-shock relations,

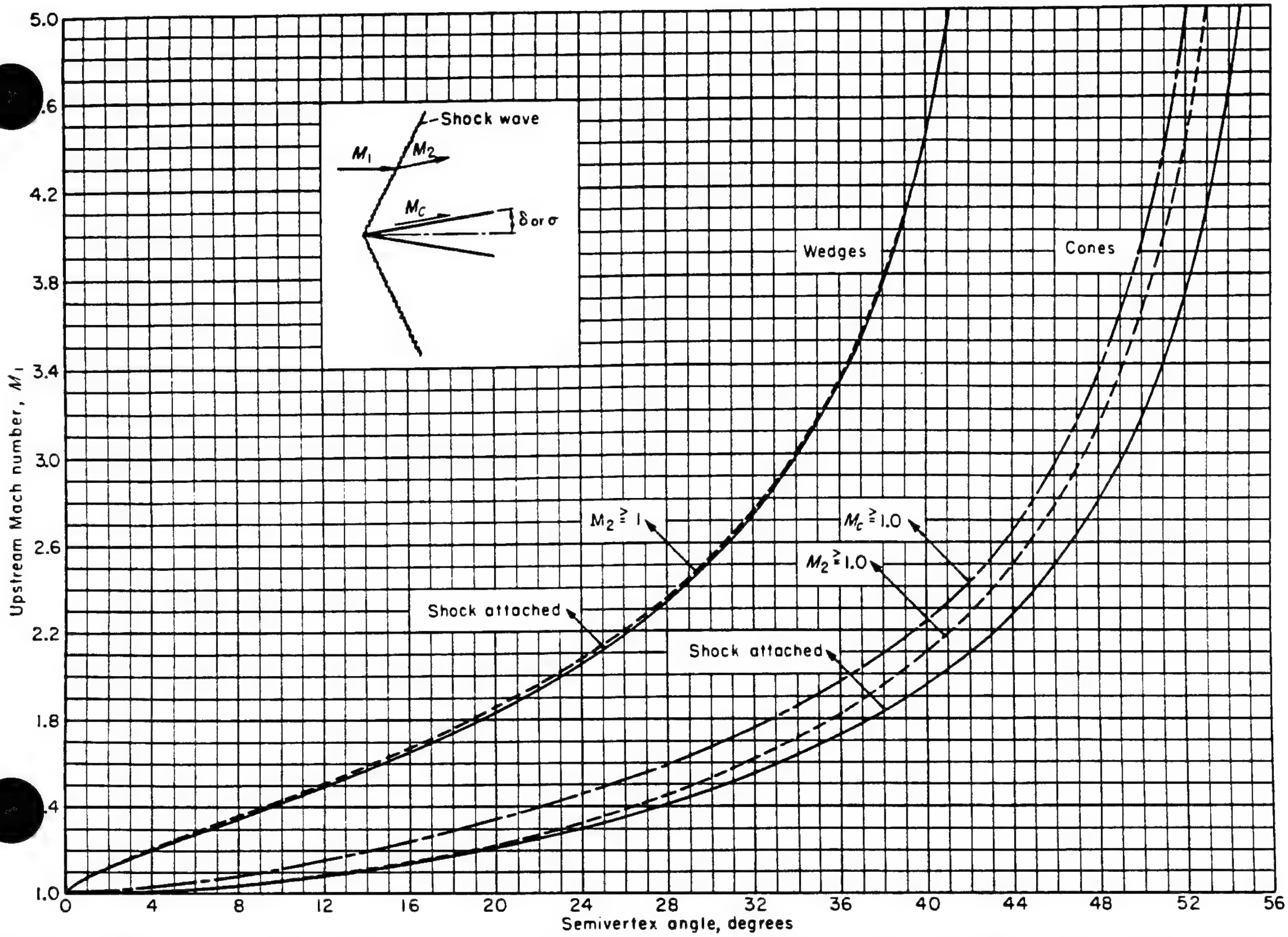

FIGURE 4.—Upstream Mach numbers for shock attachment and for supersonic flow behind shock wave on wedges and cones, and for supersonic flow at surface of cones.

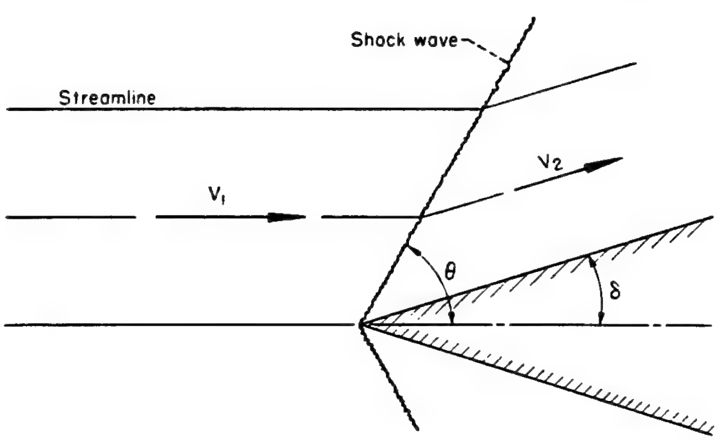

FIGURE 5.—Flow past a wedge.

and is followed by a continuous isentropic compression to face conditions, as indicated in figure 6. The flow tities have been extensively tabulated in reference 6 $\gamma=1.405$ and for $\gamma=4/3$. As in the case of wedges, two solutions exist for each cone and Mach number, but it is believed that only the weaker shock wave can occur on an isolated convex body. Charts 5, 6, and 7 show the dependence of shock-wave angle, surface-pressure coefficient, and

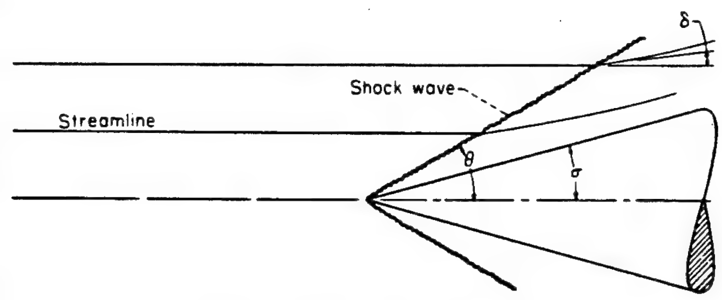

FIGURE 6.—Flow past a cone.

surface Mach number on cone semivertex angle for various free-stream Mach numbers.

The effects of slightly inclining a cone have been considered by Stone (ref. 13) and numerical results are tabulated in reference 14. Chart 8 shows the variation with Mach number of the initial slope of the normal-force curve for various cone angles. Stone has also sought an approximation for larger inclinations by retaining squares as well as first powers of angle of attack (ref. 15), and numerical results have been tabulated (ref. 16); however, these results are not free of error (see refs. 17 and 18).

PRANDTL-MEYER EXPANSION

A uniform two-dimensional supersonic stream flowing over a convex bend expands isentropically. Convenient relations are found by considering the special case of a stream at Mach number unity flowing around a sharp corner (fig. 7).

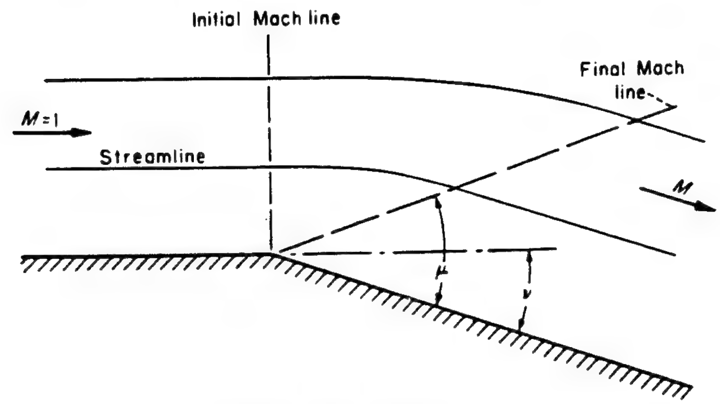

FIGURE 7.—Prandtl-Meyer expansion around a corner.

For a perfect gas, the Prandtl-Meyer angle ν through which the stream turns in expanding from $M=1$ to a supersonic Mach number M is

$$\nu=\sqrt{\frac{\gamma+1}{\gamma-1}}\tan^{-1}\sqrt{\frac{\gamma-1}{\gamma+1}(M^2-1)}-(90°-\mu) \quad (171a)$$

$$=\sqrt{\frac{\gamma+1}{\gamma-1}}\tan^{-1}\sqrt{\frac{\gamma-1}{\gamma+1}(M^2-1)}-\cos^{-1}\frac{1}{M} \quad (171b)$$

$$=\sqrt{\frac{\gamma+1}{\gamma-1}}\tan^{-1}\sqrt{\frac{\gamma-1}{\gamma+1}(M^2-1)}-\tan^{-1}\sqrt{M^2-1} \quad (171c)$$

$\left(\text{For } \gamma=7/5, \sqrt{\frac{\gamma+1}{\gamma-1}}=2.4495, \text{ and} \sqrt{\frac{\gamma-1}{\gamma+1}}=0.40825.\right)$ The maximum expansion angle, for $M=\infty$, is

$$\nu_{max}=\left(\sqrt{\frac{\gamma+1}{\gamma-1}}-1\right)\times 90°=130.45° \text{ for } \gamma=7/5 \quad (172)$$

The ratio of static to total pressure, corresponding to Mach number M is given by

$$\left(\frac{p}{p_t}\right)^{\frac{\gamma-1}{\gamma}}=\frac{1}{\gamma+1}\left\{1+\cos\left[2\sqrt{\frac{\gamma-1}{\gamma+1}}(\nu+90°-\mu)\right]\right\} \quad (173a)$$

$$=\frac{1}{\gamma+1}\left\{1+\cos\left[2\sqrt{\frac{\gamma-1}{\gamma+1}}\left(\nu+\cos^{-1}\frac{1}{M}\right)\right]\right\} \quad (173b)$$

$$=\frac{1}{\gamma+1}\left\{1+\cos\left[2\sqrt{\frac{\gamma-1}{\gamma+1}}(\nu+\tan^{-1}\sqrt{M^2-1})\right]\right\} \quad (173c)$$

which falls to zero as $\nu\rightarrow\nu_{max}$. Numerical values of ν, μ, and p/p_t are given in table II as functions of M.

These relations and the values in table II apply to a uniform stream flowing past any convex surface in the absence of external disturbances. (They also give a very good approximation at all Mach numbers when, as on an airfoil, external disturbances arise only from interaction with shock wave, and are disregarded.) If flow quantities are known at one point, the values at any second point can be read from table II by identifying the change in flow angle between the two points with $\Delta\nu=\nu_2-\nu_1$, as indicated in figure 8.

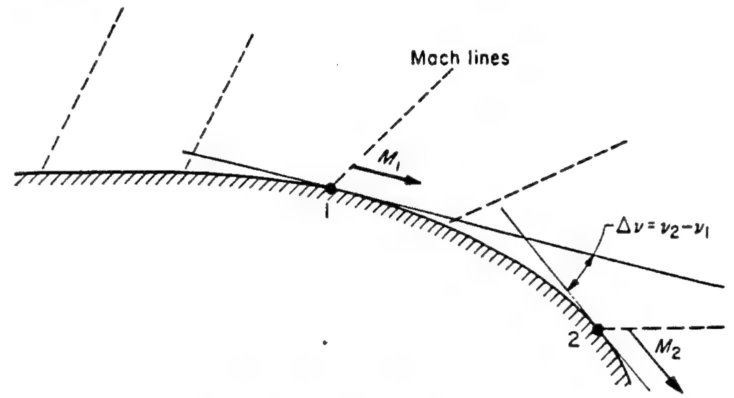

FIGURE 8.—Prandtl-Meyer expansion over a convex surface.

For expansions through small angles $\Delta\nu$, the ratio of final to initial static pressures is given by the following series ($\Delta\nu$ in radians):

$$\frac{p_2}{p_1}=1-\frac{\gamma M_1^2}{\sqrt{M_1^2-1}}(\Delta\nu)+\gamma M_1^2\frac{(\gamma+1)M_1^4-4(M_1^2-1)}{4(M_1^2-1)^2}(\Delta\nu)^2$$
$$\frac{\gamma M_1^2}{2(M_1^2-1)^{7/2}}\left[\frac{\gamma+1}{6}M_1^8-\frac{5+7\gamma-2\gamma^2}{6}M_1^6+\frac{5}{3}(\gamma+1)M_1^4-2M_1^2+\frac{4}{3}\right](\Delta\nu)^3+\ldots \quad (174)$$

Up to and including the term in $(\Delta\nu)^2$ this series is identical with that for compression through an oblique shock wave (eq. (151) with $\delta=-\Delta\nu$).

IMPERFECT-GAS EFFECTS

Methods for calculating the flow of a calorically imperfect, thermally imperfect gas and a calorically imperfect, thermally perfect gas at temperatures up to 5000° R are described in this section. The equations presented are in substantially the same form as those given in references 7 and 8. Effects of gaseous imperfections, such as molecular dissociation, which become important at temperatures greater than about 5000° R are not considered.

Atmospheric and wind-tunnel air flows are of primary concern here. In such flows air generally exhibits only caloric imperfections to any appreciable degree. Consequently, numerical results are presented only for the flow of a calorically imperfect, thermally perfect diatomic gas.

THERMODYNAMICS

EQUATIONS OF STATE

The thermal equation of state used here for a calorically and thermally imperfect gas is the Berthelot equation

(5)). The thermal equation of state used for a calorically imperfect, thermally perfect gas is equation (2). The caloric equation of state used for a calorically and thermally perfect gas is equation (8a). The caloric equation of state used for a calorically imperfect, thermally perfect gas is equation (8b).

SPECIFIC HEATS

The assumption of a simple harmonic vibrator is used to account for the contribution of the vibrational heat capacity to the specific heats. The equations for the specific heats at constant volume and constant pressure, respectively, are (see ref. 7)

$$c_v=(c_v)_{perf}\left\{1+(\gamma_{perf}-1)\left[\left(\frac{\Theta}{T}\right)^2\frac{e^{\Theta/T}}{(e^{\Theta/T}-1)^2}+\frac{2c\rho}{RT^2}\right]\right\} \tag{175}$$

$$c_v=(c_v)_{perf}\left\{1+(\gamma_{perf}-1)\left[\left(\frac{\Theta}{T}\right)^2\frac{e^{\Theta/T}}{(e^{\Theta/T}-1)^2}\right]\right\}\text{[therm perf]} \tag{176}$$

$$c_p=(c_p)_{perf}\left\{1+\frac{\gamma_{perf}-1}{\gamma_{perf}}\left[\left(\frac{\Theta}{T}\right)^2\frac{e^{\Theta/T}}{(e^{\Theta/T}-1)^2}+\frac{2c\rho}{RT^2}\left(1+\frac{\frac{2-b\rho}{1-b\rho}+\frac{c\rho}{2RT^2}}{\frac{1}{(1-b\rho)^2}-\frac{2c\rho}{RT^2}}\right)\right]\right\} \tag{177}$$

$$c_p=(c_p)_{perf}\left\{1+\frac{\gamma_{perf}-1}{\gamma_{perf}}\left[\left(\frac{\Theta}{T}\right)^2\frac{e^{\Theta/T}}{(e^{\Theta/T}-1)^2}\right]\right\}\text{[therm perf]} \tag{178}$$

The ratio of specific heats is then

$$\gamma=\gamma_{perf}\times\left[\frac{1+\frac{\gamma_{perf}-1}{\gamma_{perf}}\left\{\left(\frac{\Theta}{T}\right)^2\frac{e^{\Theta/T}}{(e^{\Theta/T}-1)^2}+\frac{2c\rho}{RT^2}\left[1+\frac{\frac{2-b\rho}{1-b\rho}+\frac{c\rho}{2RT^2}}{\frac{1}{(1-b\rho)^2}-\frac{2c\rho}{RT^2}}\right]\right\}}{1+(\gamma_{perf}-1)\left[\left(\frac{\Theta}{T}\right)^2\frac{e^{\Theta/T}}{(e^{\Theta/T}-1)^2}+\frac{2c\rho}{RT^2}\right]}\right] \tag{179}$$

or, for a thermally perfect gas,

$$\gamma=1+\frac{\gamma_{perf}-1}{1+(\gamma_{perf}-1)\left[\left(\frac{\Theta}{T}\right)^2\frac{e^{\Theta/T}}{(e^{\Theta/T}-1)^2}\right]}\text{[therm perf]} \tag{180}$$

The following values of γ are for temperatures from 400° R to 5000° R, with $\Theta=5500°$ R (see ref. 7). For engineering purposes, these are a satisfactory approximation for air.

VARIATION OF RATIO OF SPECIFIC HEATS WITH TEMPERATURE

T, °R	γ	T, °R	γ	T, °R	γ
500	1.400	1300	1.361	2200	1.322
600	1.399	1400	1.355	2400	1.317
700	1.396	1500	1.349	2600	1.313
800	1.392	1600	1.344	2800	1.309
900	1.387	1700	1.339	3000	1.306
1000	1.381	1800	1.335	3500	1.301
1100	1.375	1900	1.331	4000	1.298
1200	1.368	2000	1.328	4500	1.296
				5000	1.294

CONTINUOUS ONE-DIMENSIONAL FLOW

BASIC EQUATIONS AND DEFINITIONS

Basic equations pertinent to this section are equations (26), (27), (28), (29), (30), and (31). The equations for the speed of sound are (see ref. 7)

$$a^2=RT\left\{\frac{1}{(1-b\rho)^2}-\frac{2c\rho}{RT^2}+\frac{(\gamma_{perf}-1)\left(\frac{c\rho}{RT^2}+\frac{1}{1-b\rho}\right)^2}{1+(\gamma_{perf}-1)\left[\left(\frac{\Theta}{T}\right)^2\frac{e^{\Theta/T}}{(e^{\Theta/T}-1)^2}+\frac{2c\rho}{RT^2}\right]}\right\} \tag{181}$$

and

$$a^2=RT\left\{1+\frac{\gamma_{perf}-1}{\left[1+(\gamma_{perf}-1)\left(\frac{\Theta}{T}\right)^2\frac{e^{\Theta/T}}{(e^{\Theta/T}-1)^2}\right]}\right\}\text{[therm perf]} \tag{182}$$

INTEGRATED FORMS OF ENERGY EQUATION

The integrated forms of the energy equation are (see ref. 7)

$$V^2=2RT_t\left[\frac{1-\frac{T}{T_t}}{\gamma_{perf}-1}+\frac{\Theta}{T_t}\left(\frac{1}{e^{\Theta/T_t}-1}-\frac{1}{e^{\Theta/T}-1}\right)+\frac{2c}{RT_t}\left(\frac{\rho}{T}-\frac{\rho_t}{T_t}\right)+\frac{1}{RT_t}\left(\frac{p_t}{\rho_t}-\frac{p}{\rho}\right)\right]\text{[adiab]} \tag{183}$$

and

$$V^2=2RT_t\left[\frac{\gamma_{perf}}{\gamma_{perf}-1}\left(1-\frac{T}{T_t}\right)+\frac{\Theta}{T_t}\left(\frac{1}{e^{\Theta/T_t}-1}-\frac{1}{e^{\Theta/T}-1}\right)\right]\text{[adiab, therm perf]} \tag{184}$$

In terms of Mach number these equations become, respectively,

$$M^2=\frac{2T_t\left[\frac{1-\frac{T}{T_t}}{\gamma_{pert}-1}+\frac{\Theta}{T_t}\left(\frac{1}{e^{\Theta/T_t}-1}-\frac{1}{e^{\Theta/T}-1}\right)+\frac{2c}{RT_t}\left(\frac{\rho}{T}-\frac{\rho_t}{T_t}\right)+\frac{1}{RT_t}\left(\frac{p_t}{\rho_t}-\frac{p}{\rho}\right)\right]}{T\left\{\frac{1}{(1-b\rho)^2}-\frac{2c\rho}{RT^2}+\frac{(\gamma_{pert}-1)\left(\frac{c\rho}{RT^2}+\frac{1}{1-b\rho}\right)^2}{1+(\gamma_{pert}-1)\left[\left(\frac{\Theta}{T}\right)^2\frac{e^{\Theta/T}}{(e^{\Theta/T}-1)^2}+\frac{2c\rho}{RT^2}\right]}\right\}}\quad\text{[adiab]}\qquad(185)$$

and

$$M^2=\frac{2T_t}{\gamma T}\left[\frac{\gamma_{pert}}{\gamma_{pert}-1}\left(1-\frac{T}{T_t}\right)+\frac{\Theta}{T_t}\left(\frac{1}{e^{\Theta/T_t}-1}-\frac{1}{e^{\Theta/T}-1}\right)\right]\quad\text{[adiab, therm perf]}\qquad(186)$$

where γ is given by equation (180).

The variations of $\dfrac{\left(\frac{V}{a_*}\right)_{therm\ perf}}{\left(\frac{V}{a_*}\right)_{pert}}$ and $\dfrac{\left(\frac{T}{T_t}\right)_{therm\ perf}}{\left(\frac{T}{T_t}\right)_{pert}}$ with Mach number for several values of total temperature T_t are given in charts 9 and 10.

PRESSURE AND DENSITY RELATIONS

For isentropic flow, the relations between density and temperature are (see ref. 7)

$$\left(\frac{\rho}{\rho_t}\right)\left(\frac{1-b\rho_t}{1-b\rho}\right)=\left(\frac{e^{\Theta/T_t}-1}{e^{\Theta/T}-1}\right)\left(\frac{T}{T_t}\right)^{\frac{1}{\gamma_{pert}-1}}\exp\left[\frac{c\rho_t}{RT_t^2}-\frac{c\rho}{RT^2}+\left(\frac{\Theta}{T}\right)\frac{e^{\Theta/T}}{e^{\Theta/T}-1}-\left(\frac{\Theta}{T_t}\right)\frac{e^{\Theta/T_t}}{e^{\Theta/T_t}-1}\right]\quad\text{[isen]}\qquad(187)$$

and, for a thermally perfect gas,

$$\frac{\rho}{\rho_t}=\left(\frac{e^{\Theta/T_t}-1}{e^{\Theta/T}-1}\right)\left(\frac{T}{T_t}\right)^{\frac{1}{\gamma_{pert}-1}}\exp\left[\left(\frac{\Theta}{T}\right)\frac{e^{\Theta/T}}{e^{\Theta/T}-1}-\left(\frac{\Theta}{T_t}\right)\frac{e^{\Theta/T_t}}{e^{\Theta/T_t}-1}\right]\quad\text{[isen, therm perf]}\qquad(188)$$

The variation of $\dfrac{\left(\frac{\rho}{\rho_t}\right)_{therm\ perf}}{\left(\frac{\rho}{\rho_t}\right)_{pert}}$ with Mach number for several total temperatures is presented in chart 11.

For the isentropic flow of a thermally imperfect, calorically imperfect gas, the relation between pressure, density, and temperature can be obtained by a trial-and-error procedure using equations (5) and (187).[5] For the isentropic flow of a thermally perfect gas, the relation between pressure and temperature is

$$\frac{p}{p_t}=\left(\frac{e^{\Theta/T_t}-1}{e^{\Theta/T}-1}\right)\left(\frac{T}{T_t}\right)^{\frac{\gamma_{pert}}{\gamma_{pert}-1}}\exp\left[\left(\frac{\Theta}{T}\right)\frac{e^{\Theta/T}}{e^{\Theta/T}-1}-\left(\frac{\Theta}{T_t}\right)\frac{e^{\Theta/T_t}}{e^{\Theta/T_t}-1}\right]\quad\text{[isen, therm perf]}\qquad(189)$$

The relation between dynamic and static pressure for a thermally imperfect gas can be obtained by a trial-and-error procedure using equations (5), (31a), (183), and (187). The relation between dynamic and static pressure for a thermally perfect gas can be obtained with equations (31b) and (186), and is

$$\frac{q}{p}=\frac{\gamma_{pert}}{\gamma_{pert}-1}\left(\frac{T_t}{T}-1\right)+\frac{\Theta}{T}\left(\frac{1}{e^{\Theta/T_t}-1}-\frac{1}{e^{\Theta/T}-1}\right)\quad\text{[adiab, therm perf]}\qquad(190)$$

The variations of $\dfrac{\left(\frac{p}{p_t}\right)_{therm\ perf}}{\left(\frac{p}{p_t}\right)_{pert}}$ and $\dfrac{\left(\frac{q}{p_t}\right)_{therm\ perf}}{\left(\frac{q}{p_t}\right)_{pert}}$ with Mach number for several total temperatures are given in charts 12 and 13.

STREAM-TUBE-AREA RELATIONS

The stream-tube-area relation is given by equation (79) or, in more convenient form,

$$\frac{A}{A_*}=\frac{\rho_* a_*}{\rho a M}\qquad(191)$$

This ratio can be evaluated for a thermally imperfect gas with the aid of equations (187), (181), (5), and (185), and for a thermally perfect gas with the aid of equations (188), (182), and (186). The variation of $\dfrac{\left(\frac{A}{A_*}\right)_{therm\ perf}}{\left(\frac{A}{A_*}\right)_{pert}}$ with Mach number for several values of total temperature is presented in chart 14.

[5] In this, as in many of the cases to be presented, no direct solution for flow properties is possible if the gas exhibits both thermal and caloric imperfections. Approximate solutions of this type can be obtained, however, if the degree of imperfection is small (see ref. 7).

NORMAL SHOCK WAVES

requirements for conservation of mass, momentum, ergy across a normal shock wave are given by equations (84), (85), and (86a). The energy relation can be written

$$\frac{u_2^2}{2}-\frac{u_1^2}{2}+\frac{R}{\gamma_{perf}-1}(T_2-T_1)-\left(\frac{2c\rho_2}{T_2}-\frac{2c\rho_1}{T_1}\right)+\left(\frac{p_2}{\rho_2}-\frac{p_1}{\rho_1}\right)+$$

$$R\Theta\left(\frac{1}{e^{\Theta/T_2}-1}-\frac{1}{e^{\Theta/T_1}-1}\right)=0 \quad \text{[adiab]} \quad (192)$$

or, for a thermally perfect gas,

$$\frac{u_2^2}{2}-\frac{u_1^2}{2}+\left(\frac{\gamma_{perf}}{\gamma_{perf}-1}\right)R(T_2-T_1)+$$

$$R\Theta\left(\frac{1}{e^{\Theta/T_2}-1}-\frac{1}{e^{\Theta/T_1}-1}\right)=0 \quad \text{[adiab, therm perf]} \quad (193)$$

No explicit equation has been found to relate the temperature downstream of a normal shock wave in thermally imperfect air to the upstream conditions. A trial-and-error procedure, starting with assumed values of ρ_2 and T_2 and involving equations (5), (84), (85), and (192), can be used to determine the downstream temperature.

For the flow of a thermally perfect gas, the simultaneous tion of equations (84), (85), (193), and (2) yields the ing relation from which the temperature behind the wave can be found:

$$\left(u_1+\frac{RT_1}{u_1}\right)^2-\left(u_1+\frac{RT_1}{u_1}\right)\sqrt{\left(u_1+\frac{RT_1}{u_1}\right)^2-4RT_2}-2RT_2-$$

$$2u_1^2+\left(\frac{\gamma_{perf}}{\gamma_{perf}-1}\right)4R(T_2-T_1)-$$

$$4R\Theta\left(\frac{1}{e^{\Theta/T_2}-1}-\frac{1}{e^{\Theta/T_1}-1}\right)=0 \quad \text{[adiab, therm perf]} \quad (194)$$

Since the total temperature T_t remains constant across a shock wave, other flow parameters behind the shock wave can be found with the aid of previously presented one-dimensional flow relations. The variations of

$$\frac{\left(\frac{T_2}{T_1}\right)_{therm\ perf}}{\left(\frac{T_2}{T_1}\right)_{perf}},\ \frac{\left(\frac{\rho_2}{\rho_1}\right)_{therm\ perf}}{\left(\frac{\rho_2}{\rho_1}\right)_{perf}},\ \frac{\left(\frac{p_1}{p_{t_2}}\right)_{therm\ perf}}{\left(\frac{p_1}{p_{t_2}}\right)_{perf}},$$

$$\frac{\left(\frac{p_2}{p_1}\right)_{therm\ perf}}{\left(\frac{p_2}{p_1}\right)_{perf}},\ \frac{M_{2_{therm\ perf}}}{M_{2_{perf}}},\ \text{and}\ \frac{\left(\frac{p_{t_2}}{p_{t_1}}\right)_{therm\ perf}}{\left(\frac{p_{t_2}}{p_{t_1}}\right)_{perf}}$$

upstream Mach number for several total temperatures presented in charts 15 through 20, respectively.

OBLIQUE SHOCK WAVES

For a thermally imperfect gas, no simple equations can be found to relate the values of the flow parameters across oblique shock waves. In general, trial-and-error procedure, starting with assumed values of ρ_2 and T_2, and involving the relations for the conservation of mass, momentum, and energy, must be used. (See eqs. (115), (116), (117), and (118a) as well as equations (5) and (183).) For a thermally perfect gas, the Mach number downstream of an oblique shock wave can be found with the aid of the energy equation (see eqs. (118a) and (186)), thus

$$M_2^2=\frac{2T_1}{\gamma_2 T_2}\left[\frac{\gamma_1 M_1^2}{2}+\left(\frac{\gamma_{perf}}{\gamma_{perf}-1}\right)\left(1-\frac{T_2}{T_1}\right)+\right.$$

$$\left.\frac{\Theta}{T_1}\left(\frac{1}{e^{\Theta/T_1}-1}-\frac{1}{e^{\Theta/T_2}-1}\right)\right] \quad \text{[adiab, therm perf]} \quad (195)$$

where γ_1 and γ_2 are the functions of T_1 and T_2, respectively, given by equation (180). The pressure ratio across the shock is given by

$$\frac{p_1}{p_2}=\frac{1}{2}\left\{(1+\gamma_2 M_2^2)-\frac{T_1}{T_2}(1+\gamma_1 M_1^2)+\right.$$

$$\left.\sqrt{\left[(1+\gamma_2 M_2^2)-\frac{T_1}{T_2}(1+\gamma_1 M_1^2)\right]^2+4\frac{T_1}{T_2}}\right\}$$

$$\text{[adiab, therm perf]} \quad (196)$$

The density ratio can be determined from the equation of state (eq. (2)) with the aid of the pressure and temperature ratios. The shock-wave and deflection angles are given by (see ref. 8)

$$\sin^2\theta=\frac{\left(\frac{\gamma_2}{\gamma_1}\right)\left(\frac{T_2}{T_1}\right)\left(\frac{M_2}{M_1}\right)^2-1}{\left(\frac{\rho_1}{\rho_2}\right)^2-1} \quad \text{[adiab, therm perf]} \quad (197)$$

and

$$\cot\delta=\tan\theta\left(\frac{\frac{\gamma_1 M_1^2}{2}-1}{\frac{p_2}{p_1}-1}\right) \quad \text{[adiab, therm perf]} \quad (198)$$

respectively.

The variation of θ with δ for various values of M_1 and T_1 is presented in chart 21. In addition, the variations of

$$\frac{(M_2)_{therm\ perf}}{(M_2)_{perf}}\ \text{and}\ \frac{\left(\frac{p_2-p_1}{q_1}\right)_{therm\ perf}}{\left(\frac{p_2-p_1}{q_1}\right)_{perf}}$$

with δ for various M_1 and T_1 are presented in charts 22 and 23.

Values of the ratios

$$\frac{p_2}{p_1},\ \frac{\rho_2}{\rho_1},\ \frac{T_2}{T_1},\ \frac{p_{t_2}}{p_{t_1}}$$

for the flow of a thermally perfect gas across an oblique shock wave can be determined from the normal-shock relations,

provided that $M_1 \sin \theta$ is used instead of M_1 and that the static temperature T_1 just upstream of the shock wave is the same for the oblique shock wave as for the normal shock wave.

PRANDTL-MEYER EXPANSION

The Prandtl-Meyer angle for the flow of an imperfect gas can be found by graphically integrating the equation (see ref. 8)

$$\nu = -\int_{p_0}^{p} \frac{dp}{\rho V^2 \tan \mu} \quad \text{[isen]} \tag{199}$$

The relations between p, ρ, V, and μ can be found with the aid of equations (5), (187), (183), and (185). For a thermally perfect gas this equation becomes (see, again, ref. 8)

$$\nu = -\int_{p_0}^{p} \frac{\sin 2\mu}{2\gamma p}\, dp \quad \text{[isen, therm perf]} \tag{200}$$

The relations between γ, p, and μ can be found with the aid of equations (180), (189), and (186) using the temperature as a parameter. The graphical integration of equation (200) has been carried out, and the variations of $\nu_{therm\ perf}$ and $\frac{\nu_{therm\ perf}}{\nu_{perf}}$ with Mach number for various values of total temperature are presented in chart 24.

APPENDIX A

VISCOSITY AND THERMODYNAMIC CONSTANTS FOR AIR

VISCOSITY

The viscosity of air is nearly independent of pressure; the variation with absolute temperature, between temperatures of about 300° R and 900° R, may be approximated by the formula

$$\frac{\mu}{\mu_r}=\left(\frac{T}{T_r}\right)^{0.76} \qquad \text{(A1)}$$

For a wider range of temperatures, between about 180° R and 3400° R, Sutherland's formula (see ref. 19) is more accurate:

$$\frac{\mu}{\mu_r}=\frac{T_r+198.6}{T+198.6}\left(\frac{T}{T_r}\right)^{3/2} \qquad \text{(A2)}$$

The viscosity of air, as determined from this relation, may be expressed as

$$\mu=2.270\,\frac{T^{3/2}}{T+198.6}\times10^{-8}\,\frac{\text{lb sec}}{\text{ft}^2} \qquad \text{(A3)}$$

This latter equation has been employed in the calculations of Reynolds number (chart 25).

THERMODYNAMIC CONSTANTS

The value of γ employed for air, when treated as a completely perfect gas, is 7/5. This simple value, which has been employed in table I, table II, charts 1 to 4, and chart 25, is a good approximation to the more precise values obtained from spectroscopic measurements (see ref. 20). Values of c_p, c_v, and R for air, consistent with the approximation $\gamma=7/5$, are

$$c_p=6006 \text{ ft}^2/\text{sec}^2\ ^\circ\text{R}$$

$$c_v=4290 \text{ ft}^2/\text{sec}^2\ ^\circ\text{R}$$

$$R=1716 \text{ ft}^2/\text{sec}^2\ ^\circ\text{R}$$

APPENDIX B

REYNOLDS NUMBER

Reynolds number is defined as

$$R=\frac{\rho Vl}{\mu} \qquad \text{(B1)}$$

For sea-level conditions,

$$R\cong10{,}000\ (V \text{ in mph})\ (l \text{ in ft}) \qquad \text{(B2)}$$

In a wind tunnel (subsonic or supersonic), if isentropic expansion is assumed from a total pressure p_t and equation (A2) is used for the variation of viscosity with temperature, the Reynolds number per unit reference length is given by

$$\frac{R}{l}=\frac{p_tM}{\mu_t}\sqrt{\frac{\gamma}{(\gamma-1)c_pT_t}}\left(\frac{T_t}{T}\right)^{\frac{\gamma-2}{\gamma-1}}\frac{\frac{T}{T_t}+\frac{198.6}{T_t}}{1+\frac{198.6}{T_t}} \quad \text{[perf]} \qquad \text{(B3)}$$

The Reynolds number per unit length for $p_t=1$ psia has been plotted in chart 25 as a function of M for various total temperatures T_t.

APPENDIX C

PRESSURE CONVERSION FACTORS AND CONSTANTS

Multiply → by ↘ to obtain ↓	$\frac{\text{lb}}{\text{in.}^2}$	$\frac{\text{lb}}{\text{ft}^2}$	in. H_2O at 70° F	in. Hg at 70° F	cm. Hg at 70° F	Standard atmospheres
lb/in.^{2}	1	0.006944	0.03607	0.4892	0.1926	14.70
lb/ft^2	144	1	5.194	70.45	27.74	2117
in. H_2O (70° F)	27.73	.1925	1	13.56	5.340	407.6
in. Hg. (70° F)	2.044	.01420	.07373	1	.3937	30.05
cm. Hg. (70° F)	5.192	.03605	.1873	2.540	1	76.33
Standard atmospheres	.06804	.0004725	.002453	.03328	.01310	1

REFERENCES

1. The Staff of the Ames 1- by 3-Foot Supersonic Wind-Tunnel Section: Notes and Tables for Use in the Analysis of Supersonic Flow. NACA TN 1428, 1947.
2. Burcher, Marie A.: Compressible Flow Tables for Air. NACA TN 1592, 1948.
3. Neice, Mary M.: Tables and Charts of Flow Parameters Across Oblique Shocks. NACA TN 1673, 1948.
4. Moeckel, W. E., and Connors, J. F.: Charts for the Determination of Supersonic Air Flow Against Inclined Planes and Axially Symmetric Cones. NACA TN 1373, 1947.
5. Anon.: Handbook of Supersonic Aerodynamics. Bur. of Ord., Navy Dept. NAVORD Rep. 1488, 1950.
6. Mass. Inst. of Tech., Dept. of Elect. Engr., Center of Analysis. Tables of Supersonic Flow Around Cones by the Staff of the Computing Section, under the direction of Zdenek Kopal. Tech. Rep. no. 1. Cambridge, 1947.
7. Eggers, A. J., Jr.: One-Dimensional Flows of an Imperfect Diatomic Gas. NACA Rep. 959, 1950.
8. Eggers, A. J., Jr., and Syvertson, Clarence A.: Inviscid Flow About Airfoils at High Supersonic Speeds. NACA TN 2646, 1952.
9. Van der Waals, J. D.: The Continuity of the Liquid and Gaseous States. Physical Memoirs, Physical Society of London, vol. I. pt. 3, 1888–90, pp. 332–496.
10. Beattie, J. A., and Bridgeman, Oscar C.: A New Equation of State for Fluids. Proc. Amer. Acad. of Arts and Sci., vol. 63, no. 5, Dec. 1928, pp. 229–308.
11. Courant, R., and Friedrichs, K. O.: Supersonic Flow and Shock Waves. Interscience Publishers, Inc., New York, 1948.
12. Thompson, M. J.: A Note on the Calculation of Oblique Shock-Wave Characteristics. Jour. Aero. Sci., vol. 17, no. 11, Nov. 1950, pp. 741–744.
13. Stone, A. H.: On Supersonic Flow Past a Slightly Yawing Cone. Jour. Math. and Phys., vol. XXVII, no. 1, April 1948, pp. 67–81.
14. Mass. Inst. of Tech., Dept. of Elect. Engr., Center of Analysis. Tables of Supersonic Flow Around Yawing Cones by the Staff of the Computing Section, under the direction of Zdenek Kopal. Tech. Rep. no. 3. Cambridge, 1947.
15. Stone, A. H.: On Supersonic Flow Past a Slightly Yawing Cone II. Jour. Math. and Phys., vol. XXX, no. 4, Jan 1952.
16. Mass. Inst. of Tech., Dept. of Elect. Engr., Center of Analysis. Tables of Supersonic Flow Around Cones of Large Yaw by the Staff of the Computing Section under the direction of Zdenek Kopal. Tech. Rep. no. 5. Cambridge, 1949.
17. Moore, Franklin K.: Laminar Boundary Layer on a Circular Cone in Supersonic Flow at a Small Angle of Attack. NACA TN 2521, 1951.
18. Ferri, Antonio: Supersonic Flow Around Circular Cones at Angles of Attack. NACA Rep. 1045, 1951. (Supersedes NACA TN 2236.)
19. Anon.: The NBS-NACA Tables of Thermal Properties of Gases. Table 2.39 Dry Air, Coefficients of Viscosity. F. C. More- comp., National Bureau of Standards. Dec. 1950.
20. Anon.: The NBS-NACA Tables of Thermal Properties of Ga Table 2.10 Dry Air (Ideal Gas State), Specific Heat, Enthal Entropy. Harold W. Wooley, comp., National Bureau Standards. July 1949.

TABLES

The tables that follow contain numerical values for certain quantities often required for the solution of problems in compressible flow. The symbols used in these tables are the same as those used in the preceding sections. For convenience, however, the symbols are redefined at the end of table II.

To conserve space, a modified computing-machine notation has been adopted to indicate the position of the decimal point in the tabulated quantities. The location of the decimal point is governed by the following rules:

(a) A group of digits followed by $_{-n}$ indicates that the decimal point should be n places to the left of the first digit.

Example: $.3268_{-3}=.0003268$

(b) A group of digits followed by $_{+n}$ indicates that the decimal point should be n places to the right of the last digit.

Example: $3268_{+3}=3{,}268{,}000$

(c) A group of digits without a suffix indicates that the decimal point is correctly located as printed.

TABLE I.—SUBSONIC FLOW

The ratios given by equations (43), (44), (45), (48), (5 and (83) are given as functions of Mach number. If, at point in an isentropic flow, any one of these ratios or the Mach number is known, then all other ratios for that point can be read or interpolated from the table. In addition, the parameter $\beta=\sqrt{|M^2-1|}$, which is sometimes more convenient to use than the Mach number itself, is also tabulated.

TABLE II.—SUPERSONIC FLOW

The ratios given in table I for subsonic flow are also given in table II for supersonic flow. The Mach angle μ and the Prandtl-Meyer angle ν are also given as functions of Mach number. In addition to these point functions for isentropic flow, the normal-shock relations given by equations (93), (94), (95), (96), (99), and (100) are tabulated as functions of the Mach number M_1 ahead of the shock wave. Although these values are for normal shock waves, the values of p_2/p_1, ρ_2/ρ_1, T_2/T_1, and p_{t_2}/p_{t_1} may also be used for oblique shock waves, provided $M_1 \sin\theta$ is used instead of M_1 in the first column.

TABLE I.—SUBSONIC FLOW

$\gamma = 7/5$

M	$\frac{p}{p_t}$	$\frac{\rho}{\rho_t}$	$\frac{T}{T_t}$	β	$\frac{q}{p_t}$	$\frac{A}{A_*}$	$\frac{V}{a_*}$	M	$\frac{p}{p_t}$	$\frac{\rho}{\rho_t}$	$\frac{T}{T_t}$	β	$\frac{q}{p_t}$	$\frac{A}{A_*}$	$\frac{V}{a_*}$
0	1.0000	1.0000	1.0000	1.0000	0	∞	0	0.50	0.8430	0.8852	0.9524	0.8660	0.1475	1.3398	0.53452
.01	.9999	1.0000	1.0000	1.0000	.7000 -4	57.8738	.01095	.51	.8374	.8809	.9506	.8602	.1525	1.3212	.54469
.02	.9997	.9998	.9999	.9998	.2799 -3	28.9421	.02191	.52	.8317	.8766	.9487	.8542	.1574	1.3034	.55483
.03	.9994	.9996	.9998	.9995	.6296 -3	19.3005	.03286	.53	.8259	.8723	.9468	.8480	.1624	1.2865	.56493
.04	.9989	.9992	.9997	.9992	.1119 -2	14.4815	.04381	.54	.8201	.8679	.9449	.8417	.1674	1.2703	.57501
.05	.9983	.9988	.9995	.9987	.1747 -2	11.5914	.05476	.55	.8142	.8634	.9430	.8352	.1724	1.2550	.58506
.06	.9975	.9982	.9993	.9982	.2514 -2	9.6659	.06570	.56	.8082	.8589	.9410	.8285	.1774	1.2403	.59507
.07	.9966	.9976	.9990	.9975	.3418 -2	8.2915	.07664	.57	.8022	.8544	.9390	.8216	.1825	1.2263	.60505
.08	.9955	.9968	.9987	.9968	.4460 -2	7.2616	.08758	.58	.7962	.8498	.9370	.8146	.1875	1.2130	.61501
.09	.9944	.9960	.9984	.9959	.5638 -2	6.4613	.09851	.59	.7901	.8451	.9349	.8074	.1925	1.2003	.62492
.10	.9930	.9950	.9980	.9950	.6951 -2	5.8218	.10944	.60	.7840	.8405	.9328	.8000	.1976	1.1882	.63481
.11	.9916	.9940	.9976	.9939	.8399 -2	5.2992	.12035	.61	.7778	.8357	.9307	.7924	.2026	1.1767	.64466
.12	.9900	.9928	.9971	.9928	.9979 -2	4.8643	.13126	.62	.7716	.8310	.9286	.7846	.2076	1.1657	.65448
.13	.9383	.9916	.9966	.9915	.1169 -1	4.4969	.14217	.63	.7654	.8262	.9265	.7766	.2127	1.1552	.66427
.14	.9364	.9903	.9961	.9902	.1353 -1	4.1824	.15306	.64	.7591	.8213	.9243	.7684	.2177	1.1452	.67402
.15	.9344	.9888	.9955	.9887	.1550 -1	3.9103	.16395	.65	.7528	.8164	.9221	.7599	.2227	1.1356	.68374
.16	.9323	.9873	.9949	.9871	.1760 -1	3.6727	.17482	.66	.7465	.8115	.9199	.7513	.2276	1.1265	.69342
.17	.9800	.9857	.9943	.9854	.1983 -1	3.4635	.18569	.67	.7401	.8066	.9176	.7424	.2326	1.1179	.70307
.18	.9776	.9340	.9936	.9837	.2217 -1	3.2779	.19654	.68	.7338	.8016	.9153	.7332	.2375	1.1097	.71268
.19	.9751	.9822	.9928	.9818	.2464 -1	3.1123	.20739	.69	.7274	.7966	.9131	.7238	.2424	1.1018	.72225
.20	.9725	.9803	.9921	.9798	.2723 -1	2.9635	.21822	.70	.7209	.7916	.9107	.7141	.2473	1.0944	.73179
.21	.9697	.9783	.9913	.9777	.2994 -1	2.8293	.22904	.71	.7145	.7865	.9084	.7042	.2521	1.0873	.74129
.22	.9668	.9762	.9904	.9755	.3276 -1	2.7076	.23984	.72	.7080	.7814	.9061	.6940	.2569	1.0806	.75076
.23	.9638	.9740	.9895	.9732	.3569 -1	2.5968	.25063	.73	.7016	.7763	.9037	.6834	.2617	1.0742	.76019
.24	.9607	.9718	.9886	.9708	.3874 -1	2.4956	.26141	.74	.6951	.7712	.9013	.6726	.2664	1.0681	.76958
.25	.9575	.9694	.9877	.9682	.4189 -1	2.4027	.27217	.75	.6886	.7660	.8989	.6614	.2711	1.0624	.77894
.26	.9541	.9670	.9867	.9656	.4515 -1	2.3173	.28291	.76	.6821	.7609	.8964	.6499	.2758	1.0570	.78825
.27	.9506	.9645	.9856	.9629	.4851 -1	2.2385	.29364	.77	.6756	.7557	.8940	.6380	.2804	1.0519	.79753
.28	.9470	.9619	.9846	.9600	.5197 -1	2.1656	.30435	.78	.6691	.7505	.8915	.6258	.2849	1.0471	.80677
.29	.9433	.9592	.9835	.9570	.5553 -1	2.0979	.31504	.79	.6625	.7452	.8890	.6131	.2894	1.0425	.81597
.30	.9395	.9564	.9823	.9539	.5919 -1	2.0351	.32572	.80	.6560	.7400	.8865	.6000	.2939	1.0382	.82511
.31	.9355	.9535	.9811	.9507	.6293 -1	1.9765	.33637	.81	.6495	.7347	.8840	.5864	.2983	1.0342	.83425
.32	.9315	.9506	.9799	.9474	.6677 -1	1.9219	.34701	.82	.6430	.7295	.8815	.5724	.3027	1.0305	.84335
.33	.9274	.9476	.9787	.9440	.7069 -1	1.8707	.35762	.83	.6365	.7242	.8789	.5578	.3069	1.0270	.85239
.34	.9231	.9445	.9774	.9404	.7470 -1	1.8229	.36822	.84	.6300	.7189	.8763	.5426	.3112	1.0237	.86140
.35	.9188	.9413	.9761	.9367	.7879 -1	1.7780	.37879	.85	.6235	.7136	.8737	.5268	.3153	1.0207	.87037
.36	.9143	.9380	.9747	.9330	.8295 -1	1.7358	.38935	.86	.6170	.7083	.8711	.5103	.3195	1.0179	.87929
.37	.9098	.9347	.9733	.9290	.8719 -1	1.6961	.39988	.87	.6106	.7030	.8685	.4931	.3235	1.0153	.88818
.38	.9052	.9313	.9719	.9250	.9149 -1	1.6587	.41039	.88	.6041	.6977	.8659	.4750	.3275	1.0129	.89703
.39	.9004	.9278	.9705	.9208	.9587 -1	1.6234	.42087	.89	.5977	.6924	.8632	.4560	.3314	1.0108	.90583
.40	.8956	.9243	.9690	.9165	.1003	1.5901	.43133	.90	.5913	.6870	.8606	.4359	.3352	1.0089	.91460
.41	.8907	.9207	.9675	.9121	.1048	1.5587	.44177	.91	.5849	.6817	.8579	.4146	.3390	1.0071	.92332
.42	.8857	.9170	.9659	.9075	.1094	1.5289	.45218	.92	.5785	.6764	.8552	.3919	.3427	1.0056	.93201
.43	.8807	.9132	.9643	.9028	.1140	1.5007	.46257	.93	.5721	.6711	.8525	.3676	.3464	1.0043	.94065
.44	.8755	.9094	.9627	.8980	.1187	1.4740	.47293	.94	.5658	.6658	.8498	.3412	.3500	1.0031	.94925
.45	.8703	.9055	.9611	.8930	.1234	1.4487	.48326	.95	.5595	.6604	.8471	.3122	.3534	1.0022	.95781
.46	.8650	.9016	.9594	.8879	.1281	1.4246	.49357	.96	.5532	.6551	.8444	.2800	.3569	1.0014	.96633
.47	.8596	.8976	.9577	.8827	.1329	1.4018	.50385	.97	.5469	.6498	.8416	.2431	.3602	1.0008	.97481
.48	.8541	.8935	.9560	.8773	.1378	1.3801	.51410	.98	.5407	.6445	.8389	.1990	.3635	1.0003	.98325
.49	.8486	.8894	.9542	.8717	.1426	1.3595	.52433	.99	.5345	.6392	.8361	.1411	.3667	1.0001	.99165
								1.00	.5283	.6339	.8333	.0000	.3698	1.0000	1.00000

TABLE II.—SUPERSONIC FLOW

$\gamma = 7/5$

M or M_1	$\frac{p}{p_t}$	$\frac{\rho}{\rho_t}$	$\frac{T}{T_t}$	β	$\frac{q}{p_t}$	$\frac{A}{A_*}$	$\frac{V}{a_*}$	ν	μ	M_2	$\frac{p_2}{p_1}$	$\frac{\rho_2}{\rho_1}$	$\frac{T_2}{T_1}$	$\frac{p_{t_2}}{p_{t_1}}$	$\frac{p_1}{p_{t_2}}$
1.00	0.5283	0.6339	0.8333	0	0.3698	1.000	1.00000	0	90.00	1.000	1.000	1.000	1.000	1.000	0.5283
1.01	.5221	.6287	.8306	.1418	.3728	1.000	1.00831	.04473	81.93	.9901	1.023	1.017	1.007	1.000	.5221
1.02	.5160	.6234	.8278	.2010	.3758	1.000	1.01658	.1257	78.64	.9805	1.047	1.033	1.013	1.000	.5160
1.03	.5099	.6181	.8250	.2468	.3787	1.001	1.02481	.2294	76.14	.9712	1.071	1.050	1.020	1.000	.5100
1.04	.5039	.6129	.8222	.2857	.3815	1.001	1.03300	.3510	74.06	.9620	1.095	1.067	1.026	.9999	.5039
1.05	.4979	.6077	.8193	.3202	.3842	1.002	1.04114	.4874	72.25	.9531	1.120	1.084	1.033	.9999	.4980
1.06	.4919	.6024	.8165	.3516	.3869	1.003	1.04925	.6367	70.63	.9444	1.144	1.101	1.039	.9997	.4920
1.07	.4860	.5972	.8137	.3807	.3895	1.004	1.05731	.7973	69.16	.9360	1.169	1.118	1.046	.9996	.4861
1.08	.4800	.5920	.8108	.4079	.3919	1.005	1.06533	.9580	67.81	.9277	1.194	1.135	1.052	.9994	.4803
1.09	.4742	.5869	.8080	.4337	.3944	1.006	1.07331	1.148	66.55	.9196	1.219	1.152	1.059	.9992	.4746
1.10	.4684	.5817	.8052	.4583	.3967	1.008	1.08124	1.336	65.38	.9118	1.245	1.169	1.065	.9989	.4689
1.11	.4626	.5766	.8023	.4818	.3990	1.010	1.08913	1.532	64.28	.9041	1.271	1.186	1.071	.9986	.4632
1.12	.4568	.5714	.7994	.5044	.4011	1.011	1.09699	1.735	63.23	.8966	1.297	1.203	1.078	.9982	.4576
1.13	.4511	.5663	.7966	.5262	.4032	1.013	1.10479	1.944	62.25	.8892	1.323	1.221	1.084	.9978	.4521
1.14	.4455	.5612	.7937	.5474	.4052	1.015	1.11256	2.160	61.31	.8820	1.350	1.238	1.090	.9973	.4467
1.15	.4398	.5562	.7908	.5679	.4072	1.017	1.12029	2.381	60.41	.8750	1.376	1.255	1.097	.9967	.4413
1.16	.4343	.5511	.7879	.5879	.4090	1.020	1.12797	2.607	59.55	.8682	1.403	1.272	1.103	.9961	.4360
1.17	.4287	.5461	.7851	.6074	.4108	1.022	1.13561	2.839	58.73	.8615	1.430	1.290	1.109	.9953	.4307
1.18	.4232	.5411	.7822	.6264	.4125	1.025	1.14321	3.074	57.94	.8549	1.458	1.307	1.115	.9946	.4255
1.19	.4178	.5361	.7793	.6451	.4141	1.026	1.15077	3.314	57.18	.8485	1.485	1.324	1.122	.9937	.4204
1.20	.4124	.5311	.7764	.6633	.4157	1.030	1.15828	3.558	56.44	.8422	1.513	1.342	1.128	.9928	.4154
1.21	.4070	.5262	.7735	.6812	.4171	1.033	1.16575	3.806	55.74	.8360	1.541	1.359	1.134	.9918	.4104
1.22	.4017	.5213	.7706	.6989	.4185	1.037	1.17319	4.057	55.05	.8300	1.570	1.376	1.141	.9907	.4055
1.23	.3964	.5164	.7677	.7162	.4198	1.040	1.18057	4.312	54.39	.8241	1.598	1.394	1.147	.9896	.4006
1.24	.3912	.5115	.7648	.7332	.4211	1.043	1.18792	4.569	53.75	.8183	1.627	1.411	1.153	.9884	.3958

TABLE II.—SUPERSONIC FLOW—Continued

$\gamma=7/5$

M or M_1	$\frac{p}{p_t}$	$\frac{\rho}{\rho_t}$	$\frac{T}{T_t}$	β	$\frac{q}{p_t}$	$\frac{A}{A_*}$	$\frac{V}{a_*}$	ν	μ	M_2	$\frac{p_2}{p_1}$	$\frac{\rho_2}{\rho_1}$	$\frac{T_2}{T_1}$	$\frac{p_{t_2}}{p_{t_1}}$	$\frac{p_1}{p_{t_2}}$
1.25	.3861	.5067	.7619	.7500	.4223	1.047	1.19523	4.830	53.13	.8126	1.656	1.429	1.159	.9871	.3911
1.26	.3809	.5019	.7590	.7666	.4233	1.050	1.20249	5.093	52.53	.8071	1.686	1.446	1.166	.9857	.3865
1.27	.3759	.4971	.7561	.7829	.4244	1.054	1.20972	5.359	51.94	.8016	1.715	1.463	1.172	.9842	.3819
1.28	.3708	.4923	.7532	.7990	.4253	1.058	1.21690	5.627	51.38	.7963	1.745	1.481	1.178	.9827	.3774
1.29	.3658	.4876	.7503	.8149	.4262	1.062	1.22404	5.898	50.82	.7911	1.775	1.498	1.185	.9811	.3729
1.30	.3609	.4829	.7474	.8307	.4270	1.066	1.23114	6.170	50.28	.7860	1.805	1.516	1.191	.9794	.3685
1.31	.3560	.4782	.7445	.8462	.4277	1.071	1.23819	6.445	49.76	.7809	1.835	1.533	1.197	.9776	.3642
1.32	.3512	.4736	.7416	.8616	.4283	1.075	1.24521	6.721	49.25	.7760	1.866	1.551	1.204	.9758	.3599
1.33	.3464	.4690	.7387	.8769	.4289	1.080	1.25218	7.000	48.75	.7712	1.897	1.568	1.210	.9738	.3557
1.34	.3417	.4644	.7358	.8920	.4294	1.084	1.25912	7.280	48.27	.7664	1.928	1.585	1.216	.9718	.3516
1.35	.3370	.4598	.7329	.9069	.4299	1.089	1.26601	7.561	47.79	.7618	1.960	1.603	1.223	.9697	.3475
1.36	.3323	.4553	.7300	.9217	.4303	1.094	1.27286	7.844	47.33	.7572	1.991	1.620	1.229	.9676	.3435
1.37	.3277	.4508	.7271	.9364	.4306	1.099	1.27968	8.128	46.88	.7527	2.023	1.638	1.235	.9653	.3395
1.38	.3232	.4463	.7242	.9510	.4308	1.104	1.28645	8.413	46.44	.7483	2.055	1.655	1.242	.9630	.3356
1.39	.3187	.4418	.7213	.9655	.4310	1.109	1.29318	8.699	46.01	.7440	2.087	1.672	1.248	.9607	.3317
1.40	.3142	.4374	.7184	.9798	.4311	1.115	1.29987	8.987	45.58	.7397	2.120	1.690	1.255	.9582	.3280
1.41	.3098	.4330	.7155	.9940	.4312	1.120	1.30652	9.276	45.17	.7355	2.153	1.707	1.261	.9557	.3242
1.42	.3055	.4287	.7126	1.008	.4312	1.126	1.31313	9.565	44.77	.7314	2.186	1.724	1.268	.9531	.3205
1.43	.3012	.4244	.7097	1.022	.4311	1.132	1.31970	9.855	44.37	.7274	2.219	1.742	1.274	.9504	.3169
1.44	.2969	.4201	.7069	1.036	.4310	1.138	1.32623	10.146	43.98	.7235	2.253	1.759	1.281	.9476	.3133
1.45	.2927	.4158	.7040	1.050	.4308	1.144	1.33272	10.438	43.60	.7196	2.286	1.776	1.287	.9448	.3098
1.46	.2886	.4116	.7011	1.064	.4306	1.150	1.33917	10.731	43.23	.7157	2.320	1.793	1.294	.9420	.3063
1.47	.2845	.4074	.6982	1.077	.4303	1.156	1.34558	11.023	42.86	.7120	2.354	1.811	1.300	.9390	.3029
1.48	.2804	.4032	.6954	1.091	.4299	1.163	1.35195	11.317	42.51	.7083	2.389	1.828	1.307	.9360	.2996
1.49	.2764	.3991	.6925	1.105	.4295	1.169	1.35828	11.611	42.16	.7047	2.423	1.845	1.314	.9329	.2962
1.50	.2724	.3950	.6897	1.118	.4290	1.176	1.36458	11.905	41.81	.7011	2.458	1.862	1.320	.9298	.2930
1.51	.2685	.3909	.6868	1.131	.4285	1.183	1.37083	12.200	41.47	.6976	2.493	1.879	1.327	.9266	.2898
1.52	.2646	.3869	.6840	1.145	.4279	1.190	1.37705	12.495	41.14	.6941	2.529	1.896	1.334	.9233	.2866
1.53	.2608	.3829	.6811	1.158	.4273	1.197	1.38322	12.790	40.81	.6907	2.564	1.913	1.340	.9200	.2835
1.54	.2570	.3789	.6783	1.171	.4266	1.204	1.38936	13.086	40.49	.6874	2.600	1.930	1.347	.9166	.2804
1.55	.2533	.3750	.6754	1.184	.4259	1.212	1.39546	13.381	40.18	.6841	2.636	1.947	1.354	.9132	.2773
1.56	.2496	.3710	.6726	1.197	.4252	1.219	1.40152	13.677	39.87	.6809	2.673	1.964	1.361	.9097	.2744
1.57	.2459	.3672	.6698	1.210	.4243	1.227	1.40755	13.973	39.56	.6777	2.709	1.981	1.367	.9061	.2714
1.58	.2423	.3633	.6670	1.223	.4235	1.234	1.41353	14.269	39.27	.6746	2.746	1.998	1.374	.9026	.2685
1.59	.2388	.3595	.6642	1.236	.4226	1.242	1.41948	14.564	38.97	.6715	2.783	2.015	1.381	.8989	.2656
1.60	.2353	.3557	.6614	1.249	.4216	1.250	1.42539	14.861	38.68	.6684	2.820	2.032	1.388	.8952	.2628
1.61	.2318	.3520	.6586	1.262	.4206	1.258	1.43127	15.156	38.40	.6655	2.857	2.049	1.395	.8915	.2600
1.62	.2284	.3483	.6558	1.275	.4196	1.267	1.43710	15.452	38.12	.6625	2.895	2.065	1.402	.8877	.2573
1.63	.2250	.3446	.6530	1.287	.4185	1.275	1.44290	15.747	37.84	.6596	2.933	2.082	1.409	.8838	.2546
1.64	.2217	.3409	.6502	1.300	.4174	1.284	1.44866	16.043	37.57	.6568	2.971	2.099	1.416	.8799	.2519
1.65	.2184	.3373	.6475	1.312	.4162	1.292	1.45439	16.338	37.31	.6540	3.010	2.115	1.423	.8760	.2493
1.66	.2151	.3337	.6447	1.325	.4150	1.301	1.46008	16.633	37.04	.6512	3.048	2.132	1.430	.8720	.2467
1.67	.2119	.3302	.6419	1.337	.4138	1.310	1.46573	16.928	36.78	.6485	3.087	2.148	1.437	.8680	.2442
1.68	.2088	.3266	.6392	1.350	.4125	1.319	1.47135	17.222	36.53	.6458	3.126	2.165	1.444	.8640	.2417
1.69	.2057	.3232	.6364	1.362	.4112	1.328	1.47693	17.516	36.28	.6431	3.165	2.181	1.451	.8598	.2392
1.70	.2026	.3197	.6337	1.375	.4098	1.338	1.48247	17.810	36.03	.6405	3.205	2.198	1.458	.8557	.2368
1.71	.1996	.3163	.6310	1.387	.4085	1.347	1.48798	18.103	35.79	.6380	3.245	2.214	1.466	.8516	.2344
1.72	.1966	.3129	.6283	1.399	.4071	1.357	1.49345	18.397	35.55	.6355	3.285	2.230	1.473	.8474	.2320
1.73	.1936	.3095	.6256	1.412	.4056	1.367	1.49889	18.689	35.31	.6330	3.325	2.247	1.480	.8431	.2296
1.74	.1907	.3062	.6229	1.424	.4041	1.376	1.50429	18.981	35.08	.6305	3.366	2.263	1.487	.8389	.2273
1.75	.1878	.3029	.6202	1.436	.4026	1.386	1.50966	19.273	34.85	.6281	3.406	2.279	1.495	.8346	.2251
1.76	.1850	.2996	.6175	1.448	.4011	1.397	1.51499	19.565	34.62	.6257	3.447	2.295	1.502	.8302	.2228
1.77	.1822	.2964	.6148	1.460	.3996	1.407	1.52029	19.855	34.40	.6234	3.488	2.311	1.509	.8259	.2206
1.78	.1794	.2931	.6121	1.473	.3980	1.418	1.52555	20.146	34.18	.6210	3.530	2.327	1.517	.8215	.2184
1.79	.1767	.2900	.6095	1.485	.3964	1.428	1.53078	20.436	33.96	.6188	3.571	2.343	1.524	.8171	.2163
1.80	.1740	.2868	.6068	1.497	.3947	1.439	1.53598	20.725	33.75	.6165	3.613	2.359	1.532	.8127	.2142
1.81	.1714	.2837	.6041	1.509	.3931	1.450	1.54114	21.014	33.54	.6143	3.655	2.375	1.539	.8082	.2121
1.82	.1688	.2806	.6015	1.521	.3914	1.461	1.54626	21.302	33.33	.6121	3.698	2.391	1.547	.8038	.2100
1.83	.1662	.2776	.5989	1.533	.3897	1.472	1.55136	21.590	33.12	.6099	3.740	2.407	1.554	.7993	.2080
1.84	.1637	.2745	.5963	1.545	.3879	1.484	1.55642	21.877	32.92	.6078	3.783	2.422	1.562	.7948	.2060
1.85	.1612	.2715	.5936	1.556	.3862	1.495	1.56145	22.163	32.72	.6057	3.826	2.438	1.569	.7902	.2040
1.86	.1587	.2686	.5910	1.568	.3844	1.507	1.56644	22.449	32.52	.6036	3.870	2.454	1.577	.7857	.2020
1.87	.1563	.2656	.5884	1.580	.3826	1.519	1.57140	22.735	32.33	.6016	3.913	2.469	1.585	.7811	.2001
1.88	.1539	.2627	.5859	1.592	.3808	1.531	1.57633	23.019	32.13	.5996	3.957	2.485	1.592	.7765	.1982
1.89	.1516	.2598	.5833	1.604	.3790	1.543	1.58123	23.303	31.94	.5976	4.001	2.500	1.600	.7720	.1963
1.90	.1492	.2570	.5807	1.616	.3771	1.555	1.58609	23.586	31.76	.5956	4.045	2.516	1.608	.7674	.1945
1.91	.1470	.2542	.5782	1.627	.3753	1.568	1.59092	23.869	31.57	.5937	4.089	2.531	1.616	.7627	.1927
1.92	.1447	.2514	.5756	1.639	.3734	1.580	1.59572	24.151	31.39	.5918	4.134	2.546	1.624	.7581	.1909
1.93	.1425	.2486	.5731	1.651	.3715	1.593	1.60049	24.432	31.21	.5899	4.179	2.562	1.631	.7535	.1891
1.94	.1403	.2459	.5705	1.662	.3696	1.606	1.60523	24.712	31.03	.5880	4.224	2.577	1.639	.7488	.1873
1.95	.1381	.2432	.5680	1.674	.3677	1.619	1.60993	24.992	30.85	.5862	4.270	2.592	1.647	.7442	.1856
1.96	.1360	.2405	.5655	1.686	.3657	1.633	1.61460	25.271	30.68	.5844	4.315	2.607	1.655	.7395	.1839
1.97	.1339	.2378	.5630	1.697	.3638	1.646	1.61925	25.549	30.51	.5826	4.361	2.622	1.663	.7349	.1822
1.98	.1318	.2352	.5605	1.709	.3618	1.660	1.62386	25.827	30.33	.5808	4.407	2.637	1.671	.7302	.1806
1.99	.1298	.2326	.5580	1.720	.3598	1.674	1.62844	26.104	30.17	.5791	4.453	2.652	1.679	.7255	.1789
2.00	.1278	.2300	.5556	1.732	.3579	1.688	1.63299	26.380	30.00	.5774	4.500	2.667	1.688	.7209	.1773
2.01	.1258	.2275	.5531	1.744	.3559	1.702	1.63751	26.655	29.84	.5757	4.547	2.681	1.696	.7162	.1757
2.02	.1239	.2250	.5506	1.755	.3539	1.716	1.64201	26.929	29.67	.5740	4.594	2.696	1.704	.7115	.1741
2.03	.1220	.2225	.5482	1.767	.3518	1.730	1.64647	27.203	29.51	.5723	4.641	2.711	1.712	.7069	.1726
2.04	.1201	.2200	.5458	1.778	.3498	1.745	1.65090	27.476	29.35	.5707	4.689	2.725	1.720	.7022	.1710
2.05	.1182	.2176	.5433	1.790	.3478	1.760	1.65530	27.748	29.20	.5691	4.736	2.740	1.729	.6975	.1695
2.06	.1164	.2152	.5409	1.801	.3458	1.775	1.65967	28.020	29.04	.5675	4.784	2.755	1.737	.6928	.1680
2.07	.1146	.2128	.5385	1.812	.3437	1.790	1.66402	28.290	28.89	.5659	4.832	2.769	1.745	.6882	.1665
2.08	.1128	.2104	.5361	1.824	.3417	1.806	1.66833	28.560	28.74	.5643	4.881	2.783	1.754	.6835	.1651
2.09	.1111	.2081	.5337	1.835	.3396	1.821	1.67262	28.829	28.59	.5628	4.929	2.798	1.762	.6789	.1636
2.10	.1094	.2058	.5313	1.847	.3376	1.837	1.67687	29.097	28.44	.5613	4.978	2.812	1.770	.6742	.1622
2.11	.1077	.2035	.5290	1.858	.3355	1.853	1.68110	29.364	28.29	.5598	5.027	2.826	1.779	.6696	.1608
2.12	.1060	.2013	.5266	1.869	.3334	1.869	1.68530	29.631	28.14	.5583	5.077	2.840	1.787	.6649	.1594
2.13	.1043	.1990	.5243	1.881	.3314	1.885	1.68947	29.897	28.00	.5568	5.126	2.854	1.796	.6603	.1580
2.14	.1027	.1968	.5219	1.892	.3293	1.902	1.69362	30.161	27.86	.5554	5.176	2.868	1.805	.6557	.1567

TABLE II.—SUPERSONIC FLOW—Continued

$\gamma = 7/5$

M or M_1	$\frac{p}{p_t}$	$\frac{\rho}{\rho_t}$	$\frac{T}{T_t}$	β	$\frac{q}{p_t}$	$\frac{A}{A_*}$	$\frac{V}{a_*}$	ν	μ	M_2	$\frac{p_2}{p_1}$	$\frac{\rho_2}{\rho_1}$	$\frac{T_2}{T_1}$	$\frac{p_{t_2}}{p_{t_1}}$	$\frac{p_1}{p_{t_2}}$
2.15	.1011	.1946	.5196	1.903	.3272	1.919	1.69774	30.425	27.72	.5540	5.226	2.882	1.813	.6511	.1553
2.16	.9956 -1	.1925	.5173	1.915	.3252	1.935	1.70183	30.689	27.58	.5525	5.277	2.896	1.822	.6464	.1540
2.17	.9802 -1	.1903	.5150	1.926	.3231	1.953	1.70589	30.951	27.44	.5511	5.327	2.910	1.831	.6419	.1527
2.18	.9649 -1	.1882	.5127	1.937	.3210	1.970	1.70992	31.212	27.30	.5498	5.378	2.924	1.839	.6373	.1514
2.19	.9500 -1	.1861	.5104	1.948	.3189	1.987	1.71393	31.473	27.17	.5484	5.429	2.938	1.848	.6327	.1502
2.20	.9352 -1	.1841	.5081	1.960	.3169	2.005	1.71791	31.732	27.04	.5471	5.480	2.951	1.857	.6281	.1489
2.21	.9207 -1	.1820	.5059	1.971	.3148	2.023	1.72187	31.991	26.90	.5457	5.531	2.965	1.866	.6236	.1476
2.22	.9064 -1	.1800	.5036	1.982	.3127	2.041	1.72579	32.250	26.77	.5444	5.583	2.978	1.875	.6191	.1464
2.23	.8923 -1	.1780	.5014	1.993	.3106	2.059	1.72970	32.507	26.64	.5431	5.636	2.992	1.883	.6145	.1452
2.24	.8785 -1	.1760	.4991	2.004	.3085	2.078	1.73357	32.763	26.51	.5418	5.687	3.005	1.892	.6100	.1440
2.25	.8648 -1	.1740	.4969	2.016	.3065	2.096	1.73742	33.018	26.39	.5406	5.740	3.019	1.901	.6055	.1428
2.26	.8514 -1	.1721	.4947	2.027	.3044	2.115	1.74125	33.273	26.26	.5393	5.792	3.032	1.910	.6011	.1417
2.27	.8382 -1	.1702	.4925	2.038	.3023	2.134	1.74504	33.527	26.14	.5381	5.845	3.045	1.919	.5966	.1405
2.28	.8251 -1	.1683	.4903	2.049	.3003	2.154	1.74882	33.780	26.01	.5368	5.898	3.058	1.929	.5921	.1394
2.29	.8123 -1	.1664	.4881	2.060	.2982	2.173	1.75257	34.032	25.89	.5356	5.951	3.071	1.938	.5877	.1382
2.30	.7997 -1	.1646	.4859	2.071	.2961	2.193	1.75629	34.283	25.77	.5344	6.005	3.085	1.947	.5833	.1371
2.31	.7873 -1	.1628	.4837	2.082	.2941	2.213	1.75999	34.533	25.65	.5332	6.059	3.098	1.956	.5789	.1360
2.32	.7751 -1	.1609	.4816	2.093	.2920	2.233	1.76366	34.783	25.53	.5321	6.113	3.110	1.965	.5745	.1349
2.33	.7631 -1	.1592	.4794	2.104	.2900	2.254	1.76731	35.031	25.42	.5309	6.167	3.123	1.974	.5702	.1338
2.34	.7512 -1	.1574	.4773	2.116	.2879	2.274	1.77093	35.279	25.30	.5297	6.222	3.136	1.984	.5658	.1328
2.35	.7396 -1	.1556	.4752	2.127	.2859	2.295	1.77453	35.526	25.18	.5286	6.276	3.149	1.993	.5615	.1317
2.36	.7281 -1	.1539	.4731	2.138	.2839	2.316	1.77811	35.771	25.07	.5275	6.331	3.162	2.002	.5572	.1307
2.37	.7168 -1	.1522	.4709	2.149	.2818	2.338	1.78166	36.017	24.96	.5264	6.386	3.174	2.012	.5529	.1297
2.38	.7057 -1	.1505	.4688	2.160	.2798	2.359	1.78519	36.261	24.85	.5253	6.442	3.187	2.021	.5486	.1286
2.39	.6948 -1	.1488	.4668	2.171	.2778	2.381	1.78869	36.504	24.73	.5242	6.497	3.199	2.031	.5444	.1276
2.40	.6840 -1	.1472	.4647	2.182	.2758	2.403	1.79218	36.746	24.62	.5231	6.553	3.212	2.040	.5401	.1266
2.41	.6734 -1	.1456	.4626	2.193	.2738	2.425	1.79563	36.988	24.52	.5221	6.609	3.224	2.050	.5359	.1257
2.42	.6630 -1	.1439	.4606	2.204	.2718	2.448	1.79907	37.229	24.41	.5210	6.666	3.237	2.059	.5317	.1247
2.43	.6527 -1	.1424	.4585	2.215	.2698	2.471	1.80248	37.469	24.30	.5200	6.722	3.249	2.069	.5276	.1237
2.44	.6426 -1	.1408	.4565	2.226	.2678	2.494	1.80587	37.708	24.19	.5189	6.779	3.261	2.079	.5234	.1228
2.45	.6327 -1	.1392	.4544	2.237	.2658	2.517	1.80924	37.946	24.09	.5179	6.836	3.273	2.088	.5193	.1218
2.46	.6229 -1	.1377	.4524	2.248	.2639	2.540	1.81258	38.183	23.99	.5169	6.894	3.285	2.098	.5152	.1209
2.47	.6133 -1	.1362	.4504	2.259	.2619	2.564	1.81591	38.420	23.88	.5159	6.951	3.298	2.108	.5111	.1200
2.48	.6038 -1	.1346	.4484	2.269	.2599	2.588	1.81921	38.655	23.78	.5149	7.009	3.310	2.118	.5071	.1191
2.49	.5945 -1	.1332	.4464	2.280	.2580	2.612	1.82249	38.890	23.68	.5140	7.067	3.321	2.128	.5030	.1182
2.50	.5853 -1	.1317	.4444	2.291	.2561	2.637	1.82574	39.124	23.58	.5130	7.125	3.333	2.138	.4990	.1173
2.51	.5762 -1	.1302	.4425	2.302	.2541	2.661	1.82898	39.357	23.48	.5120	7.183	3.345	2.147	.4950	.1164
2.52	.5674 -1	.1288	.4405	2.313	.2522	2.686	1.83219	39.589	23.38	.5111	7.242	3.357	2.157	.4911	.1155
2.53	.5586 -1	.1274	.4386	2.324	.2503	2.712	1.83538	39.820	23.28	.5102	7.301	3.369	2.167	.4871	.1147
2.54	.5500 -1	.1260	.4366	2.335	.2484	2.737	1.83855	40.050	23.18	.5092	7.360	3.380	2.177	.4832	.1138
2.55	.5415 -1	.1246	.4347	2.346	.2465	2.763	1.84170	40.280	23.09	.5083	7.420	3.392	2.187	.4793	.1130
2.56	.5332 -1	.1232	.4328	2.357	.2446	2.789	1.84483	40.509	22.99	.5074	7.479	3.403	2.198	.4754	.1122
2.57	.5250 -1	.1218	.4309	2.367	.2427	2.815	1.84794	40.736	22.91	.5065	7.539	3.415	2.208	.4715	.1113
2.58	.5169 -1	.1205	.4289	2.378	.2409	2.842	1.85103	40.963	22.81	.5056	7.599	3.426	2.218	.4677	.1105
2.59	.5090 -1	.1192	.4271	2.389	.2390	2.869	1.85410	41.189	22.71	.5047	7.659	3.438	2.228	.4639	.1097
2.60	.5012 -1	.1179	.4252	2.400	.2371	2.896	1.85714	41.415	22.62	.5039	7.720	3.449	2.238	.4601	.1080
2.61	.4935 -1	.1166	.4233	2.411	.2353	2.923	1.86017	41.639	22.53	.5030	7.781	3.460	2.249	.4564	.1081
2.62	.4859 -1	.1153	.4214	2.422	.2335	2.951	1.86318	41.863	22.44	.5022	7.842	3.471	2.259	.4526	.1074
2.63	.4784 -1	.1140	.4196	2.432	.2317	2.979	1.86616	42.086	22.35	.5013	7.903	3.483	2.269	.4489	.1066
2.64	.4711 -1	.1128	.4177	2.443	.2298	3.007	1.86913	42.307	22.26	.5005	7.965	3.494	2.280	.4452	.1058
2.65	.4639 -1	.1115	.4159	2.454	.2280	3.036	1.87208	42.529	22.17	.4996	8.026	3.505	2.290	.4416	.1051
2.66	.4568 -1	.1103	.4141	2.465	.2262	3.065	1.87501	42.749	22.08	.4988	8.088	3.516	2.301	.4379	.1043
2.67	.4498 -1	.1091	.4122	2.476	.2245	3.094	1.87792	42.968	22.00	.4980	8.150	3.527	2.311	.4343	.1036
2.68	.4429 -1	.1079	.4104	2.486	.2227	3.123	1.88081	43.187	21.91	.4972	8.213	3.537	2.322	.4307	.1028
2.69	.4362 -1	.1067	.4086	2.497	.2209	3.153	1.88368	43.405	21.82	.4964	8.275	3.548	2.332	.4271	.1021
2.70	.4295 -1	.1056	.4068	2.508	.2192	3.183	1.88653	43.621	21.74	.4956	8.338	3.559	2.343	.4236	.1014
2.71	.4229 -1	.1044	.4051	2.519	.2174	3.213	1.88936	43.838	21.65	.4949	8.401	3.570	2.354	.4201	.1007
2.72	.4165 -1	.1033	.4033	2.530	.2157	3.244	1.89218	44.053	21.57	.4941	8.465	3.580	2.364	.4166	.9998 -1
2.73	.4102 -1	.1022	.4015	2.540	.2140	3.275	1.89497	44.267	21.49	.4933	8.528	3.591	2.375	.4131	.9929 -1
2.74	.4039 -1	.1010	.3998	2.551	.2123	3.306	1.89775	44.481	21.41	.4926	8.592	3.601	2.386	.4097	.9860 -1
2.75	.3978 -1	.9994 -1	.3980	2.562	.2106	3.338	1.90051	44.694	21.32	.4918	8.656	3.612	2.397	.4062	.9792 -1
2.76	.3917 -1	.9885 -1	.3963	2.572	.2089	3.370	1.90325	44.906	21.24	.4911	8.721	3.622	2.407	.4028	.9724 -1
2.77	.3858 -1	.9778 -1	.3945	2.583	.2072	3.402	1.90598	45.117	21.16	.4903	8.785	3.633	2.418	.3994	.9658 -1
2.78	.3799 -1	.9671 -1	.3928	2.594	.2055	3.434	1.90868	45.327	21.08	.4896	8.850	3.643	2.429	.3961	.9591 -1
2.79	.3742 -1	.9566 -1	.3911	2.605	.2039	3.467	1.91137	45.537	21.00	.4889	8.915	3.653	2.440	.3928	.9526 -1
2.80	.3685 -1	.9463 -1	.3894	2.615	.2022	3.500	1.91404	45.746	20.92	.4882	8.980	3.664	2.451	.3895	.9461 -1
2.81	.3629 -1	.9360 -1	.3877	2.626	.2006	3.534	1.91669	45.954	20.85	.4875	9.045	3.674	2.462	.3862	.9397 -1
2.82	.3574 -1	.9259 -1	.3860	2.637	.1990	3.567	1.91933	46.161	20.77	.4868	9.111	3.684	2.473	.3829	.9334 -1
2.83	.3520 -1	.9158 -1	.3844	2.647	.1973	3.601	1.92195	46.368	20.69	.4861	9.177	3.694	2.484	.3797	.9271 -1
2.84	.3467 -1	.9059 -1	.3827	2.658	.1957	3.636	1.92455	46.573	20.62	.4854	9.243	3.704	2.496	.3765	.9209 -1
2.85	.3415 -1	.8962 -1	.3810	2.669	.1941	3.671	1.92714	46.778	20.54	.4847	9.310	3.714	2.507	.3733	.9147 -1
2.86	.3363 -1	.8865 -1	.3794	2.679	.1926	3.706	1.92970	46.982	20.47	.4840	9.376	3.724	2.518	.3701	.9086 -1
2.87	.3312 -1	.8769 -1	.3777	2.690	.1910	3.741	1.93225	47.185	20.39	.4833	9.443	3.734	2.529	.3670	.9026 -1
2.88	.3263 -1	.8675 -1	.3761	2.701	.1894	3.777	1.93479	47.386	20.32	.4827	9.510	3.743	2.540	.3639	.8966 -1
2.89	.3213 -1	.8581 -1	.3745	2.711	.1879	3.813	1.93731	47.589	20.24	.4820	9.577	3.753	2.552	.3608	.8906 -1
2.90	.3165 -1	.8489 -1	.3729	2.722	.1863	3.850	1.93981	47.790	20.17	.4814	9.645	3.763	2.563	.3577	.8848 -1
2.91	.3118 -1	.8398 -1	.3712	2.733	.1848	3.887	1.94230	47.990	20.10	.4807	9.713	3.773	2.575	.3547	.8790 -1
2.92	.3071 -1	.8307 -1	.3696	2.743	.1833	3.924	1.94477	48.190	20.03	.4801	9.781	3.782	2.586	.3517	.8732 -1
2.93	.3025 -1	.8218 -1	.3681	2.754	.1818	3.961	1.94722	48.388	19.96	.4795	9.849	3.792	2.598	.3487	.8675 -1
2.94	.2980 -1	.8130 -1	.3665	2.765	.1803	3.999	1.94966	48.586	19.89	.4788	9.918	3.801	2.609	.3457	.8619 -1
2.95	.2935 -1	.8043 -1	.3649	2.775	.1788	4.038	1.95208	48.783	19.81	.4782	9.986	3.811	2.621	.3428	.8563 -1
2.96	.2891 -1	.7957 -1	.3633	2.786	.1773	4.076	1.95449	48.980	19.75	.4776	10.06	3.820	2.632	.3398	.8507 -1
2.97	.2848 -1	.7872 -1	.3618	2.797	.1758	4.115	1.95688	49.175	19.68	.4770	10.12	3.829	2.644	.3369	.8453 -1
2.98	.2805 -1	.7788 -1	.3602	2.807	.1744	4.155	1.95925	49.370	19.61	.4764	10.19	3.839	2.656	.3340	.8398 -1
2.99	.2764 -1	.7705 -1	.3587	2.818	.1729	4.194	1.96162	49.564	19.54	.4758	10.26	3.848	2.667	.3312	.8345 -1
3.00	.2722 -1	.7623 -1	.3571	2.828	.1715	4.235	1.96396	49.757	19.47	.4752	10.33	3.857	2.679	.3283	.8291 -1
3.01	.2682 -1	.7541 -1	.3556	2.839	.1701	4.275	1.96629	49.950	19.40	.4746	10.40	3.866	2.691	.3255	.8238 -1
3.02	.2642 -1	.7461 -1	.3541	2.850	.1687	4.316	1.96861	50.142	19.34	.4740	10.47	3.875	2.703	.3227	.8186 -1
3.03	.2603 -1	.7382 -1	.3526	2.860	.1673	4.357	1.97091	50.333	19.27	.4734	10.54	3.884	2.714	.3200	.8134 -1
3.04	.2564 -1	.7303 -1	.3511	2.871	.1659	4.399	1.97319	50.523	19.20	.4729	10.62	3.893	2.726	.3172	.8083 -1

TABLE II.—SUPERSONIC FLOW—Continued

$\gamma=7/5$

M or M_1	$\frac{p}{p_t}$	$\frac{\rho}{\rho_t}$	$\frac{T}{T_t}$	β	$\frac{q}{p_t}$	$\frac{A}{A_*}$	$\frac{V}{a_*}$	ν	μ	M_2	$\frac{p_2}{p_1}$	$\frac{\rho_2}{\rho_1}$	$\frac{T_2}{T_1}$	$\frac{p_{t_2}}{p_{t_1}}$	$\frac{p_1}{p_{t_2}}$
3.05	.2526 -1	.7226 -1	.3496	2.881	.1645	4.441	1.97547	50.713	19.14	.4723	10.69	3.902	2.738	.3145	.8032 -1
3.06	.2489 -1	.7149 -1	.3481	2.892	.1631	4.483	1.97772	50.902	19.07	.4717	10.76	3.911	2.750	.3118	.7982 -1
3.07	.2452 -1	.7074 -1	.3466	2.903	.1618	4.526	1.97997	51.090	19.01	.4712	10.83	3.920	2.762	.3091	.7932 -1
3.08	.2416 -1	.6999 -1	.3452	2.913	.1604	4.570	1.98219	51.277	18.95	.4706	10.90	3.929	2.774	.3065	.7882 -1
3.09	.2380 -1	.6925 -1	.3437	2.924	.1591	4.613	1.98441	51.464	18.88	.4701	10.97	3.938	2.786	.3038	.7833 -1
3.10	.2345 -1	.6852 -1	.3422	2.934	.1577	4.657	1.98661	51.650	18.82	.4695	11.05	3.947	2.799	.3012	.7785 -1
3.11	.2310 -1	.6779 -1	.3408	2.945	.1564	4.702	1.98879	51.835	18.76	.4690	11.12	3.955	2.811	.2986	.7737 -1
3.12	.2276 -1	.6708 -1	.3393	2.955	.1551	4.747	1.99097	52.020	18.69	.4685	11.19	3.964	2.823	.2960	.7689 -1
3.13	.2243 -1	.6637 -1	.3379	2.966	.1538	4.792	1.99313	52.203	18.63	.4679	11.26	3.973	2.835	.2935	.7642 -1
3.14	.2210 -1	.6568 -1	.3365	2.977	.1525	4.838	1.99527	52.386	18.57	.4674	11.34	3.981	2.848	.2910	.7595 -1
3.15	.2177 -1	.6499 -1	.3351	2.987	.1512	4.884	1.99740	52.569	18.51	.4669	11.41	3.990	2.860	.2885	.7549 -1
3.16	.2146 -1	.6430 -1	.3337	2.998	.1500	4.930	1.99952	52.751	18.45	.4664	11.48	3.998	2.872	.2860	.7503 -1
3.17	.2114 -1	.6363 -1	.3323	3.008	.1487	4.977	2.00162	52.931	18.39	.4659	11.56	4.006	2.885	.2835	.7457 -1
3.18	.2083 -1	.6296 -1	.3309	3.019	.1475	5.025	2.00372	53.112	18.33	.4654	11.63	4.015	2.897	.2811	.7412 -1
3.19	.2053 -1	.6231 -1	.3295	3.029	.1462	5.073	2.00579	53.292	18.27	.4648	11.71	4.023	2.909	.2786	.7367 -1
3.20	.2023 -1	.6165 -1	.3281	3.040	.1450	5.121	2.00786	53.470	18.21	.4643	11.78	4.031	2.922	.2762	.7323 -1
3.21	.1993 -1	.6101 -1	.3267	3.050	.1438	5.170	2.00991	53.648	18.15	.4639	11.85	4.040	2.935	.2738	.7279 -1
3.22	.1964 -1	.6037 -1	.3253	3.061	.1426	5.219	2.01195	53.826	18.09	.4634	11.93	4.048	2.947	.2715	.7235 -1
3.23	.1936 -1	.5975 -1	.3240	3.071	.1414	5.268	2.01398	54.003	18.03	.4629	12.01	4.056	2.960	.2691	.7192 -1
3.24	.1908 -1	.5912 -1	.3226	3.082	.1402	5.319	2.01599	54.179	17.98	.4624	12.08	4.064	2.972	.2668	.7149 -1
3.25	.1880 -1	.5851 -1	.3213	3.092	.1390	5.369	2.01799	54.355	17.92	.4619	12.16	4.072	2.985	.2645	.7107 -1
3.26	.1853 -1	.5790 -1	.3199	3.103	.1378	5.420	2.01998	54.529	17.86	.4614	12.23	4.080	2.998	.2622	.7065 -1
3.27	.1826 -1	.5730 -1	.3186	3.113	.1367	5.472	2.02196	54.703	17.81	.4610	12.31	4.088	3.011	.2600	.7023 -1
3.28	.1799 -1	.5671 -1	.3173	3.124	.1355	5.523	2.02392	54.877	17.75	.4605	12.38	4.096	3.023	.2577	.6982 -1
3.29	.1773 -1	.5612 -1	.3160	3.134	.1344	5.576	2.02587	55.050	17.70	.4600	12.46	4.104	3.036	.2555	.6941 -1
3.30	.1748 -1	.5554 -1	.3147	3.145	.1332	5.629	2.02781	55.222	17.64	.4596	12.54	4.112	3.049	.2533	.6900 -1
3.31	.1722 -1	.5497 -1	.3134	3.155	.1321	5.682	2.02974	55.393	17.58	.4591	12.62	4.120	3.062	.2511	.6860 -1
3.32	.1698 -1	.5440 -1	.3121	3.166	.1310	5.736	2.03165	55.564	17.53	.4587	12.69	4.128	3.075	.2489	.6820 -1
3.33	.1673 -1	.5384 -1	.3108	3.176	.1299	5.790	2.03356	55.734	17.48	.4582	12.77	4.135	3.088	.2468	.6781 -1
3.34	.1649 -1	.5329 -1	.3095	3.187	.1288	5.845	2.03545	55.904	17.42	.4578	12.85	4.143	3.101	.2446	.6741 -1
3.35	.1625 -1	.5274 -1	.3082	3.197	.1277	5.900	2.03733	56.073	17.37	.4573	12.93	4.151	3.114	.2425	.6702 -1
3.36	.1602 -1	.5220 -1	.3069	3.208	.1266	5.956	2.03920	56.241	17.31	.4569	13.00	4.158	3.127	.2404	.6664 -1
3.37	.1579 -1	.5166 -1	.3057	3.218	.1255	6.012	2.04106	56.409	17.26	.4565	13.08	4.166	3.141	.2383	.6626 -1
3.38	.1557 -1	.5113 -1	.3044	3.229	.1245	6.069	2.04290	56.576	17.21	.4560	13.16	4.173	3.154	.2363	.6588 -1
3.39	.1534 -1	.5061 -1	.3032	3.239	.1234	6.126	2.04474	56.742	17.16	.4556	13.24	4.181	3.167	.2342	.6550 -1
3.40	.1512 -1	.5009 -1	.3019	3.250	.1224	6.184	2.04656	56.907	17.10	.4552	13.32	4.188	3.180	.2322	.6513 -1
3.41	.1491 -1	.4958 -1	.3007	3.260	.1214	6.242	2.04837	57.073	17.05	.4548	13.40	4.196	3.194	.2302	.6476 -1
3.42	.1470 -1	.4908 -1	.2995	3.271	.1203	6.301	2.05017	57.237	17.00	.4544	13.48	4.203	3.207	.2282	.6439
3.43	.1449 -1	.4858 -1	.2982	3.281	.1193	6.360	2.05196	57.401	16.95	.4540	13.56	4.211	3.220	.2263	.6403
3.44	.1428 -1	.4808 -1	.2970	3.291	.1183	6.420	2.05374	57.564	16.90	.4535	13.64	4.218	3.234	.2243	.6367
3.45	.1408 -1	.4759 -1	.2958	3.302	.1173	6.480	2.05551	57.726	16.85	.4531	13.72	4.225	3.247	.2224	.6331
3.46	.1388 -1	.4711 -1	.2946	3.312	.1163	6.541	2.05727	57.888	16.80	.4527	13.80	4.232	3.261	.2205	.6296 -1
3.47	.1368 -1	.4663 -1	.2934	3.323	.1153	6.602	2.05901	58.050	16.75	.4523	13.88	4.240	3.274	.2186	.6261 -1
3.48	.1349 -1	.4616 -1	.2922	3.333	.1144	6.664	2.06075	58.210	16.70	.4519	13.96	4.247	3.288	.2167	.6226 -1
3.49	.1330 -1	.4569 -1	.2910	3.344	.1134	6.727	2.06247	58.370	16.65	.4515	14.04	4.254	3.301	.2148	.6191 -1
3.50	.1311 -1	.4523 -1	.2899	3.354	.1124	6.790	2.06419	58.530	16.60	.4512	14.13	4.261	3.315	.2129	.6157 -1
3.51	.1293 -1	.4478 -1	.2887	3.365	.1115	6.853	2.06589	58.689	16.55	.4508	14.21	4.268	3.329	.2111	.6123 -1
3.52	.1274 -1	.4433 -1	.2875	3.375	.1105	6.917	2.06759	58.847	16.51	.4504	14.29	4.275	3.343	.2093	.6089 -1
3.53	.1256 -1	.4388 -1	.2864	3.385	.1096	6.982	2.06927	59.004	16.46	.4500	14.37	4.282	3.356	.2075	.6056 -1
3.54	.1239 -1	.4344 -1	.2852	3.396	.1087	7.047	2.07094	59.162	16.41	.4496	14.45	4.289	3.370	.2057	.6023 -1
3.55	.1221 -1	.4300 -1	.2841	3.406	.1078	7.113	2.07261	59.318	16.36	.4492	14.54	4.296	3.384	.2039	.5990 -1
3.56	.1204 -1	.4257 -1	.2829	3.417	.1069	7.179	2.07426	59.474	16.31	.4489	14.62	4.303	3.398	.2022	.5957 -1
3.57	.1188 -1	.4214 -1	.2818	3.427	.1059	7.246	2.07590	59.629	16.27	.4485	14.70	4.309	3.412	.2004	.5925 -1
3.58	.1171 -1	.4172 -1	.2806	3.437	.1051	7.313	2.07754	59.784	16.22	.4481	14.79	4.316	3.426	.1987	.5892 -1
3.59	.1155 -1	.4131 -1	.2795	3.448	.1042	7.382	2.07916	59.938	16.17	.4478	14.87	4.323	3.440	.1970	.5861 -1
3.60	.1138 -1	.4089 -1	.2784	3.458	.1033	7.450	2.08077	60.091	16.13	.4474	14.95	4.330	3.454	.1953	.5829 -1
3.61	.1123 -1	.4049 -1	.2773	3.469	.1024	7.519	2.08238	60.244	16.08	.4471	15.04	4.336	3.468	.1936	.5798 -1
3.62	.1107 -1	.4008 -1	.2762	3.479	.1016	7.589	2.08397	60.397	16.04	.4467	15.12	4.343	3.482	.1920	.5767 -1
3.63	.1092 -1	.3968 -1	.2751	3.490	.1007	7.659	2.08556	60.549	15.99	.4463	15.21	4.350	3.496	.1903	.5736 -1
3.64	.1076 -1	.3929 -1	.2740	3.500	.9984 -1	7.730	2.08713	60.700	15.95	.4460	15.29	4.356	3.510	.1887	.5705 -1
3.65	.1062 -1	.3890 -1	.2729	3.510	.9900 -1	7.802	2.08870	60.851	15.90	.4456	15.38	4.363	3.525	.1871	.5675 -1
3.66	.1047 -1	.3852 -1	.2718	3.521	.9817 -1	7.874	2.09026	61.000	15.86	.4453	15.46	4.369	3.539	.1855	.5645 -1
3.67	.1032 -1	.3813 -1	.2707	3.531	.9734 -1	7.947	2.09180	61.150	15.81	.4450	15.55	4.376	3.553	.1839	.5615 -1
3.68	.1018 -1	.3776 -1	.2697	3.542	.9652 -1	8.020	2.09334	61.299	15.77	.4446	15.63	4.382	3.568	.1823	.5585 -1
3.69	.1004 -1	.3739 -1	.2686	3.552	.9570 -1	8.094	2.09487	61.447	15.72	.4443	15.72	4.388	3.582	.1807	.5556 -1
3.70	.9903 -2	.3702 -1	.2675	3.562	.9490 -1	8.169	2.09639	61.595	15.68	.4439	15.81	4.395	3.596	.1792	.5526 -1
3.71	.9767 -2	.3665 -1	.2665	3.573	.9410 -1	8.244	2.09790	61.743	15.64	.4436	15.89	4.401	3.611	.1777	.5497 -1
3.72	.9633 -2	.3629 -1	.2654	3.583	.9331 -1	8.320	2.09941	61.889	15.59	.4433	15.98	4.408	3.625	.1761	.5469 -1
3.73	.9500 -2	.3594 -1	.2644	3.593	.9253 -1	8.397	2.10090	62.036	15.55	.4430	16.07	4.414	3.640	.1746	.5440 -1
3.74	.9370 -2	.3558 -1	.2633	3.604	.9175 -1	8.474	2.10238	62.181	15.51	.4426	16.15	4.420	3.654	.1731	.5412 -1
3.75	.9242 -2	.3524 -1	.2623	3.614	.9098 -1	8.552	2.10386	62.326	15.47	.4423	16.24	4.426	3.669	.1717	.5384 -1
3.76	.9116 -2	.3489 -1	.2613	3.625	.9021 -1	8.630	2.10533	62.471	15.42	.4420	16.33	4.432	3.684	.1702	.5356 -1
3.77	.8991 -2	.3455 -1	.2602	3.635	.8945 -1	8.709	2.10679	62.615	15.38	.4417	16.42	4.439	3.698	.1687	.5328 -1
3.78	.8869 -2	.3421 -1	.2592	3.645	.8870 -1	8.789	2.10824	62.758	15.34	.4414	16.50	4.445	3.713	.1673	.5301 -1
3.79	.8748 -2	.3388 -1	.2582	3.656	.8796 -1	8.870	2.10968	62.901	15.30	.4410	16.59	4.451	3.728	.1659	.5274 -1
3.80	.8629 -2	.3355 -1	.2572	3.666	.8722 -1	8.951	2.11111	63.044	15.26	.4407	16.68	4.457	3.743	.1645	.5247 -1
3.81	.8512 -2	.3322 -1	.2562	3.676	.8649 -1	9.032	2.11254	63.186	15.22	.4404	16.77	4.463	3.758	.1631	.5220 -1
3.82	.8396 -2	.3290 -1	.2552	3.687	.8577 -1	9.115	2.11395	63.327	15.18	.4401	16.86	4.469	3.772	.1617	.5193 -1
3.83	.8283 -2	.3258 -1	.2542	3.697	.8505 -1	9.198	2.11536	63.468	15.14	.4398	16.95	4.475	3.787	.1603	.5167 -1
3.84	.8171 -2	.3227 -1	.2532	3.708	.8434 -1	9.282	2.11676	63.608	15.10	.4395	17.04	4.481	3.802	.1589	.5140 -1
3.85	.8060 -2	.3195 -1	.2522	3.718	.8363 -1	9.366	2.11815	63.748	15.06	.4392	17.13	4.487	3.817	.1576	.5114
3.86	.7951 -2	.3165 -1	.2513	3.728	.8293 -1	9.451	2.11954	63.887	15.02	.4389	17.22	4.492	3.832	.1563	.5089
3.87	.7844 -2	.3134 -1	.2503	3.739	.8224 -1	9.537	2.12091	64.026	14.98	.4386	17.31	4.498	3.847	.1549	.5063
3.88	.7739 -2	.3104 -1	.2493	3.749	.8155 -1	9.624	2.12228	64.164	14.94	.4383	17.40	4.504	3.863	.1536	.5038
3.89	.7635 -2	.3074 -1	.2484	3.759	.8087 -1	9.711	2.12364	64.302	14.90	.4380	17.49	4.510	3.878	.1523	.5012
3.90	.7532 -2	.3044 -1	.2474	3.770	.8019 -1	9.799	2.12499	64.440	14.86	.4377	17.58	4.516	3.893	.1510	.4987 -1
3.91	.7431 -2	.3015 -1	.2464	3.780	.7952 -1	9.888	2.12634	64.576	14.82	.4375	17.67	4.521	3.908	.1497	.4962 -1
3.92	.7332 -2	.2986 -1	.2455	3.790	.7886 -1	9.977	2.12767	64.713	14.78	.4372	17.76	4.527	3.923	.1485	.4938 -1
3.93	.7233 -2	.2958 -1	.2446	3.801	.7820 -1	10.07	2.12900	64.848	14.74	.4369	17.85	4.533	3.939	.1472	.4913 -1
3.94	.7137 -2	.2929 -1	.2436	3.811	.7755 -1	10.16	2.13032	64.983	14.70	.4366	17.94	4.538	3.954	.1460	.4889 -1

TABLE II.—SUPERSONIC FLOW—Continued

$\gamma=7/5$

M or M_1	$\frac{p}{p_t}$	$\frac{\rho}{\rho_t}$	$\frac{T}{T_t}$	β	$\frac{q}{p_t}$	$\frac{A}{A_*}$	$\frac{V}{a_*}$	ν	μ	M_2	$\frac{p_2}{p_1}$	$\frac{\rho_2}{\rho_1}$	$\frac{T_2}{T_1}$	$\frac{p_{t_2}}{p_{t_1}}$	$\frac{p_1}{p_{t_2}}$
3.95	.7042 -2	.2902 -1	.2427	3.821	.7691 -1	10.25	2.13163	65.118	14.67	.4363	18.04	4.544	3.969	.1448	.4865 -1
3.96	.6948 -2	.2874 -1	.2418	3.832	.7627 -1	10.34	2.13294	65.253	14.63	.4360	18.13	4.549	3.985	.1435	.4841 -1
3.97	.6855 -2	.2846 -1	.2408	3.842	.7563 -1	10.44	2.13424	65.386	14.59	.4358	18.22	4.555	4.000	.1423	.4817 -1
3.98	.6764 -2	.2819 -1	.2399	3.852	.7500 -1	10.53	2.13553	65.520	14.55	.4355	18.31	4.560	4.016	.1411	.4793 -1
3.99	.6675 -2	.2793 -1	.2390	3.863	.7438 -1	10.62	2.13681	65.652	14.52	.4352	18.41	4.566	4.031	.1399	.4770 -1
4.00	.6586 -2	.2766 -1	.2381	3.873	.7376 -1	10.72	2.13809	65.785	14.48	.4350	18.50	4.571	4.047	.1388	.4747 -1
4.01	.6499 -2	.2740 -1	.2372	3.883	.7315 -1	10.81	2.13936	65.917	14.44	.4347	18.59	4.577	4.062	.1376	.4723 -1
4.02	.6413 -2	.2714 -1	.2363	3.894	.7255 -1	10.91	2.14062	66.048	14.40	.4344	18.69	4.582	4.078	.1364	.4700 -1
4.03	.6328 -2	.2688 -1	.2354	3.904	.7194 -1	11.01	2.14188	66.179	14.37	.4342	18.78	4.588	4.094	.1353	.4678 -1
4.04	.6245 -2	.2663 -1	.2345	3.914	.7135 -1	11.11	2.14312	66.309	14.33	.4339	18.88	4.593	4.110	.1342	.4655 -1
4.05	.6163 -2	.2638 -1	.2336	3.925	.7076 -1	11.21	2.14436	66.439	14.30	.4336	18.97	4.598	4.125	.1330	.4633 -1
4.06	.6082 -2	.2613 -1	.2327	3.935	.7017 -1	11.31	2.14560	66.569	14.26	.4334	19.06	4.604	4.141	.1319	.4610 -1
4.07	.6002 -2	.2589 -1	.2319	3.945	.6959 -1	11.41	2.14682	66.698	14.22	.4331	19.16	4.609	4.157	.1308	.4588 -1
4.08	.5923 -2	.2564 -1	.2310	3.956	.6902 -1	11.51	2.14804	66.826	14.19	.4329	19.25	4.614	4.173	.1297	.4566 -1
4.09	.5845 -2	.2540 -1	.2301	3.966	.6845 -1	11.61	2.14926	66.954	14.15	.4326	19.35	4.619	4.189	.1286	.4544 -1
4.10	.5769 -2	.2516 -1	.2293	3.976	.6788 -1	11.71	2.15046	67.082	14.12	.4324	19.45	4.624	4.205	.1276	.4523 -1
4.11	.5694 -2	.2493 -1	.2284	3.986	.6732 -1	11.82	2.15166	67.209	14.08	.4321	19.54	4.630	4.221	.1265	.4501 -1
4.12	.5619 -2	.2470 -1	.2275	3.997	.6677 -1	11.92	2.15285	67.336	14.05	.4319	19.64	4.635	4.237	.1254	.4480 -1
4.13	.5546 -2	.2447 -1	.2267	4.007	.6622 -1	12.03	2.15404	67.462	14.01	.4316	19.73	4.640	4.253	.1244	.4459 -1
4.14	.5474 -2	.2424 -1	.2258	4.017	.6568 -1	12.14	2.15522	67.588	13.98	.4314	19.83	4.645	4.269	.1234	.4438 -1
4.15	.5403 -2	.2401 -1	.2250	4.028	.6514 -1	12.24	2.15639	67.713	13.94	.4311	19.93	4.650	4.285	.1223	.4417 -1
4.16	.5333 -2	.2379 -1	.2242	4.038	.6460 -1	12.35	2.15756	67.838	13.91	.4309	20.02	4.655	4.301	.1213	.4396 -1
4.17	.5264 -2	.2357 -1	.2233	4.048	.6407 -1	12.46	2.15871	67.963	13.88	.4306	20.12	4.660	4.318	.1203	.4375 -1
4.18	.5195 -2	.2335 -1	.2225	4.059	.6354 -1	12.57	2.15987	68.087	13.84	.4304	20.22	4.665	4.334	.1193	.4355 -1
4.19	.5128 -2	.2313 -1	.2217	4.069	.6302 -1	12.68	2.16101	68.210	13.81	.4302	20.32	4.670	4.350	.1183	.4334 -1
4.20	.5062 -2	.2292 -1	.2208	4.079	.6251 -1	12.79	2.16215	68.333	13.77	.4299	20.41	4.675	4.367	.1173	.4314 -1
4.21	.4997 -2	.2271 -1	.2200	4.090	.6200 -1	12.90	2.16329	68.456	13.74	.4297	20.51	4.680	4.383	.1164	.4294 -1
4.22	.4932 -2	.2250 -1	.2192	4.100	.6149 -1	13.02	2.16442	68.578	13.71	.4295	20.61	4.685	4.399	.1154	.4274 -1
4.23	.4869 -2	.2229 -1	.2184	4.110	.6098 -1	13.13	2.16554	68.700	13.67	.4292	20.71	4.690	4.416	.1144	.4255 -1
4.24	.4806 -2	.2209 -1	.2176	4.120	.6049 -1	13.25	2.16665	68.821	13.64	.4290	20.81	4.694	4.432	.1135	.4235 -1
4.25	.4745 -2	.2189 -1	.2168	4.131	.5999 -1	13.36	2.16776	68.942	13.61	.4288	20.91	4.699	4.449	.1126	.4215 -1
4.26	.4684 -2	.2169 -1	.2160	4.141	.5950 -1	13.48	2.16886	69.063	13.58	.4286	21.01	4.704	4.466	.1116	.4196 -1
4.27	.4624 -2	.2149 -1	.2152	4.151	.5902 -1	13.60	2.16996	69.183	13.54	.4283	21.11	4.709	4.482	.1107	.4177 -1
4.28	.4565 -2	.2129 -1	.2144	4.162	.5854 -1	13.72	2.17105	69.302	13.51	.4281	21.20	4.713	4.499	.1098	.4158 -1
4.29	.4507 -2	.2110 -1	.2136	4.172	.5806 -1	13.83	2.17214	69.422	13.48	.4279	21.30	4.718	4.516	.1089	.4139 -1
4.30	.4449 -2	.2090 -1	.2129	4.182	.5759 -1	13.95	2.17321	69.541	13.45	.4277	21.41	4.723	4.532	.1080	.4120 -1
4.31	.4393 -2	.2071 -1	.2121	4.192	.5712 -1	14.08	2.17429	69.659	13.42	.4275	21.51	4.728	4.549	.1071	.4101 -1
4.32	.4337 -2	.2052 -1	.2113	4.203	.5666 -1	14.20	2.17535	69.777	13.38	.4272	21.61	4.732	4.566	.1062	.4082 -1
4.33	.4282 -2	.2034 -1	.2105	4.213	.5620 -1	14.32	2.17642	69.895	13.35	.4270	21.71	4.737	4.583	.1054	.4064 -1
4.34	.4228 -2	.2015 -1	.2098	4.223	.5574 -1	14.45	2.17747	70.012	13.32	.4268	21.81	4.741	4.600	.1045	.4046 -1
4.35	.4174 -2	.1997 -1	.2090	4.233	.5529 -1	14.57	2.17852	70.128	13.29	.4266	21.91	4.746	4.617	.1036	.4027 -1
4.36	.4121 -2	.1979 -1	.2083	4.244	.5484 -1	14.70	2.17956	70.245	13.26	.4264	22.01	4.751	4.633	.1028	.4009 -1
4.37	.4069 -2	.1961 -1	.2075	4.254	.5440 -1	14.82	2.18060	70.361	13.23	.4262	22.11	4.755	4.651	.1020	.3991 -1
4.38	.4018 -2	.1944 -1	.2067	4.264	.5396 -1	14.95	2.18163	70.476	13.20	.4260	22.22	4.760	4.668	.1011	.3973 -1
4.39	.3968 -2	.1926 -1	.2060	4.275	.5352 -1	15.08	2.18266	70.591	13.17	.4258	22.32	4.764	4.685	.1003	.3956 -1
4.40	.3918 -2	.1909 -1	.2053	4.285	.5309 -1	15.21	2.18368	70.706	13.14	.4255	22.42	4.768	4.702	.9948 -1	.3938 -1
4.41	.3868 -2	.1892 -1	.2045	4.295	.5266 -1	15.34	2.18470	70.820	13.11	.4253	22.52	4.773	4.719	.9867 -1	.3921 -1
4.42	.3820 -2	.1875 -1	.2038	4.305	.5224 -1	15.47	2.18571	70.934	13.08	.4251	22.63	4.777	4.736	.9787 -1	.3903 -1
4.43	.3772 -2	.1858 -1	.2030	4.316	.5182 -1	15.61	2.18671	71.048	13.05	.4249	22.73	4.782	4.753	.9707 -1	.3886 -1
4.44	.3725 -2	.1841 -1	.2023	4.326	.5140 -1	15.74	2.187714	71.161	13.02	.4247	22.83	4.786	4.771	.9628 -1	.3869 -1
4.45	.3678 -2	.1825 -1	.2016	4.336	.5099 -1	15.87	2.188708	71.274	12.99	.4245	22.94	4.790	4.788	.9550 -1	.3852 -1
4.46	.3633 -2	.1808 -1	.2009	4.346	.5058 -1	16.01	2.189697	71.386	12.96	.4243	23.04	4.795	4.805	.9473 -1	.3835 -1
4.47	.3587 -2	.1792 -1	.2002	4.357	.5017 -1	16.15	2.190681	71.498	12.93	.4241	23.14	4.799	4.823	.9396 -1	.3818 -1
4.48	.3543 -2	.1776 -1	.1994	4.367	.4977 -1	16.28	2.191659	71.610	12.90	.4239	23.25	4.803	4.840	.9320 -1	.3801 -1
4.49	.3499 -2	.1761 -1	.1987	4.377	.4937 -1	16.42	2.192632	71.721	12.87	.4237	23.35	4.808	4.858	.9244 -1	.3785 -1
4.50	.3455 -2	.1745 -1	.1980	4.387	.4898 -1	16.56	2.193600	71.832	12.84	.4236	23.46	4.812	4.875	.9170 -1	.3768 -1
4.51	.3412 -2	.1729 -1	.1973	4.398	.4859 -1	16.70	2.194563	71.942	12.81	.4234	23.56	4.816	4.893	.9096 -1	.3752 -1
4.52	.3370 -2	.1714 -1	.1966	4.408	.4820 -1	16.84	2.195520	72.052	12.78	.4232	23.67	4.820	4.910	.9022 -1	.3735 -1
4.53	.3329 -2	.1699 -1	.1959	4.418	.4781 -1	16.99	2.196473	72.162	12.75	.4230	23.77	4.824	4.928	.8950 -1	.3719 -1
4.54	.3288 -2	.1684 -1	.1952	4.428	.4743 -1	17.13	2.197420	72.271	12.73	.4228	23.88	4.829	4.946	.8878 -1	.3703 -1
4.55	.3247 -2	.1669 -1	.1945	4.439	.4706 -1	17.28	2.198363	72.380	12.70	.4226	23.99	4.833	4.963	.8806 -1	.3687 -1
4.56	.3207 -2	.1654 -1	.1938	4.449	.4668 -1	17.42	2.199300	72.489	12.67	.4224	24.09	4.837	4.981	.8735 -1	.3671 -1
4.57	.3168 -2	.1640 -1	.1932	4.459	.4631 -1	17.57	2.200233	72.597	12.64	.4222	24.20	4.841	4.999	.8665 -1	.3656 -1
4.58	.3129 -2	.1625 -1	.1925	4.469	.4594 -1	17.72	2.201160	72.705	12.61	.4220	24.31	4.845	5.017	.8596 -1	.3640 -1
4.59	.3090 -2	.1611 -1	.1918	4.480	.4558 -1	17.87	2.202033	72.812	12.58	.4219	24.41	4.849	5.034	.8527 -1	.3624 -1
4.60	.3053 -2	.1597 -1	.1911	4.490	.4522 -1	18.02	2.203000	72.919	12.56	.4217	24.52	4.853	5.052	.8459 -1	.3609 -1
4.61	.3015 -2	.1583 -1	.1905	4.500	.4486 -1	18.17	2.203913	73.026	12.53	.4215	24.63	4.857	5.070	.8391 -1	.3593 -1
4.62	.2978 -2	.1569 -1	.1898	4.510	.4450 -1	18.32	2.204822	73.132	12.50	.4213	24.74	4.861	5.088	.8324 -1	.3578 -1
4.63	.2942 -2	.1556 -1	.1891	4.521	.4415 -1	18.48	2.205725	73.238	12.47	.4211	24.84	4.865	5.106	.8257 -1	.3563 -1
4.64	.2906 -2	.1542 -1	.1885	4.531	.4380 -1	18.63	2.206624	73.344	12.45	.4210	24.95	4.869	5.124	.8192 -1	.3548 -1
4.65	.2871 -2	.1529 -1	.1878	4.541	.4345 -1	18.79	2.207518	73.449	12.42	.4208	25.06	4.873	5.143	.8126 -1	.3533 -1
4.66	.2836 -2	.1515 -1	.1872	4.551	.4311 -1	18.94	2.208407	73.554	12.39	.4206	25.17	4.877	5.160	.8062 -1	.3518 -1
4.67	.2802 -2	.1502 -1	.1865	4.562	.4277 -1	19.10	2.209291	73.659	12.37	.4204	25.28	4.881	5.179	.7998 -1	.3503 -1
4.68	.2768 -2	.1489 -1	.1859	4.572	.4243 -1	19.26	2.210171	73.763	12.34	.4203	25.39	4.885	5.197	.7934 -1	.3488 -1
4.69	.2734 -2	.1476 -1	.1852	4.582	.4210 -1	19.42	2.211047	73.867	12.31	.4201	25.50	4.889	5.215	.7871 -1	.3474 -1
4.70	.2701 -2	.1464 -1	.1846	4.592	.4177 -1	19.58	2.211918	73.970	12.28	.4199	25.61	4.893	5.233	.7809 -1	.3459 -1
4.71	.2669 -2	.1451 -1	.1839	4.603	.4144 -1	19.75	2.212784	74.073	12.26	.4197	25.71	4.896	5.252	.7747 -1	.3445 -1
4.72	.2637 -2	.1438 -1	.1833	4.613	.4112 -1	19.91	2.213646	74.176	12.23	.4196	25.82	4.900	5.270	.7685 -1	.3431 -1
4.73	.2605 -2	.1426 -1	.1827	4.623	.4079 -1	20.07	2.214503	74.279	12.21	.4194	25.94	4.904	5.289	.7625 -1	.3416 -1
4.74	.2573 -2	.1414 -1	.1820	4.633	.4047 -1	20.24	2.215356	74.381	12.18	.4192	26.05	4.908	5.307	.7561 -1	.3402 -1
4.75	.2543 -2	.1402 -1	.1814	4.644	.4016 -1	20.41	2.216205	74.483	12.15	.4191	26.16	4.912	5.325	.7505 -1	.3388 -1
4.76	.2512 -2	.1390 -1	.1808	4.654	.3984 -1	20.58	2.217049	74.584	12.13	.4189	26.27	4.915	5.344	.7445 -1	.3374 -1
4.77	.2482 -2	.1378 -1	.1802	4.664	.3953 -1	20.75	2.217889	74.685	12.10	.4187	26.38	4.919	5.363	.7387 -1	.3360 -1
4.78	.2452 -2	.1366 -1	.1795	4.674	.3922 -1	20.92	2.218725	74.786	12.08	.4186	26.49	4.923	5.381	.7329 -1	.3346 -1
4.79	.2423 -2	.1354 -1	.1789	4.684	.3892 -1	21.09	2.219556	74.886	12.05	.4184	26.60	4.926	5.400	.7271 -1	.3333 -1
4.80	.2394 -2	.1343 -1	.1783	4.695	.3862 -1	21.26	2.220383	74.986	12.03	.4183	26.71	4.930	5.418	.7214 -1	.3319 -1
4.81	.2366 -2	.1331 -1	.1777	4.705	.3832 -1	21.44	2.221206	75.086	12.00	.4181	26.83	4.934	5.437	.7157 -1	.3305 -1
4.82	.2338 -2	.1320 -1	.1771	4.715	.3802 -1	21.61	2.222024	75.186	11.97	.4179	26.94	4.937	5.456	.7101 -1	.3292 -1
4.83	.2310 -2	.1309 -1	.1765	4.725	.3772 -1	21.79	2.222838	75.285	11.95	.4178	27.05	4.941	5.475	.7046 -1	.3278 -1
4.84	.2283 -2	.1298 -1	.1759	4.736	.3743 -1	21.97	2.223649	75.383	11.92	.4176	27.16	4.945	5.494	.6991 -1	.3265 -1

TABLE II.—SUPERSONIC FLOW—Continued

$\gamma=7/5$

M or M_1	$\frac{p}{p_t}$	$\frac{\rho}{\rho_t}$	$\frac{T}{T_t}$	β	$\frac{q}{p_t}$	$\frac{A}{A_*}$	$\frac{V}{a_*}$	ν	μ	M_2	$\frac{p_2}{p_1}$	$\frac{\rho_2}{\rho_1}$	$\frac{T_2}{T_1}$	$\frac{p_{t_2}}{p_{t_1}}$	$\frac{p_1}{p_{t_2}}$
4.85	.2255 -2	.1287 -1	.1753	4.746	.3714 -1	22.15	2.224455	75.482	11.90	.4175	27.28	4.948	5.512	.6936 -1	.3252 -1
4.86	.2229 -2	.1276 -1	.1747	4.756	.3685 -1	22.33	2.225257	75.580	11.87	.4173	27.39	4.952	5.531	.6882 -1	.3239 -1
4.87	.2202 -2	.1265 -1	.1741	4.766	.3657 -1	22.51	2.226055	75.678	11.85	.4172	27.50	4.955	5.550	.6828 -1	.3226 -1
4.88	.2177 -2	.1254 -1	.1735	4.776	.3628 -1	22.70	2.226848	75.775	11.83	.4170	27.62	4.959	5.569	.6775 -1	.3213 -1
4.89	.2151 -2	.1244 -1	.1729	4.787	.3600 -1	22.88	2.227638	75.872	11.80	.4169	27.73	4.962	5.588	.6722 -1	.3200 -1
4.90	.2126 -2	.1233 -1	.1724	4.797	.3573 -1	23.07	2.228424	75.969	11.78	.4167	27.85	4.966	5.607	.6670 -1	.3187 -1
4.91	.2101 -2	.1223 -1	.1718	4.807	.3545 -1	23.25	2.229206	76.066	11.75	.4165	27.96	4.969	5.626	.6618 -1	.3174 -1
4.92	.2076 -2	.1213 -1	.1712	4.817	.3518 -1	23.44	2.229984	76.162	11.73	.4164	28.07	4.973	5.646	.6567 -1	.3161 -1
4.93	.2052 -2	.1202 -1	.1706	4.828	.3491 -1	23.63	2.230758	76.258	11.70	.4163	28.19	4.976	5.665	.6516 -1	.3149 -1
4.94	.2028 -2	.1192 -1	.1700	4.838	.3464 -1	23.82	2.231528	76.353	11.68	.4161	28.30	4.980	5.684	.6465 -1	.3136 -1
4.95	.2004 -2	.1182 -1	.1695	4.848	.3437 -1	24.02	2.232294	76.449	11.66	.4160	28.42	4.983	5.703	.6415 -1	.3124 -1
4.96	.1981 -2	.1173 -1	.1689	4.858	.3411 -1	24.21	2.233056	76.544	11.63	.4158	28.54	4.987	5.723	.6366 -1	.3111 -1
4.97	.1957 -2	.1163 -1	.1683	4.868	.3385 -1	24.41	2.233815	76.638	11.61	.4157	28.65	4.990	5.742	.6317 -1	.3099 -1
4.98	.1935 -2	.1153 -1	.1678	4.879	.3359 -1	24.60	2.234570	76.732	11.58	.4155	28.77	4.993	5.761	.6268 -1	.3087 -1
4.99	.1912 -2	.1144 -1	.1672	4.889	.3333 -1	24.80	2.235321	76.826	11.56	.4154	28.88	4.997	5.781	.6220 -1	.3075 -1
5.00	.1890 -2	.1134 -1	.1667	4.899	.3308 -1	25.00	2.236068	76.920	11.54	.4152	29.00	5.000	5.800	.6172 -1	.3062 -1
5.01	.1868 -2	.1125 -1	.1661	4.909	.3282 -1	25.20	2.236811	77.013	11.51	.4151	29.12	5.003	5.820	.6124 -1	.3051 -1
5.02	.1847 -2	.1115 -1	.1656	4.919	.3257 -1	25.40	2.237551	77.106	11.49	.4149	29.23	5.007	5.839	.6077 -1	.3039 -1
5.03	.1825 -2	.1106 -1	.1650	4.930	.3233 -1	25.61	2.238287	77.199	11.47	.4148	29.35	5.010	5.859	.6030 -1	.3027 -1
5.04	.1804 -2	.1097 -1	.1645	4.940	.3208 -1	25.81	2.239020	77.291	11.44	.4147	29.47	5.013	5.878	.5981 -1	.3015 -1
5.05	.1783 -2	.1088 -1	.1639	4.950	.3184 -1	26.02	2.239749	77.385	11.42	.4145	29.59	5.016	5.898	.5938 -1	.3003 -1
5.06	.1763 -2	.1079 -1	.1634	4.960	.3159 -1	26.22	2.240474	77.477	11.40	.4144	29.70	5.020	5.918	.5893 -1	.2991 -1
5.07	.1742 -2	.1070 -1	.1628	4.970	.3135 -1	26.43	2.241195	77.568	11.38	.4142	29.82	5.023	5.937	.5848 -1	.2980 -1
5.08	.1722 -2	.1061 -1	.1623	4.981	.3112 -1	26.64	2.241914	77.660	11.35	.4141	29.94	5.026	5.957	.5803 -1	.2968 -1
5.09	.1703 -2	.1053 -1	.1618	4.991	.3088 -1	26.86	2.242628	77.751	11.33	.4140	30.06	5.029	5.977	.5759 -1	.2957 -1
5.10	.1683 -2	.1044 -1	.1612	5.001	.3065 -1	27.07	2.243339	77.841	11.31	.4138	30.18	5.033	5.997	.5715 -1	.2945 -1
5.11	.1664 -2	.1035 -1	.1607	5.011	.3042 -1	27.28	2.244047	77.931	11.29	.4137	30.30	5.036	6.016	.5672 -1	.2934 -1
5.12	.1645 -2	.1027 -1	.1602	5.021	.3019 -1	27.50	2.244751	78.021	11.26	.4136	30.42	5.039	6.036	.5628 -1	.2923 -1
5.13	.1626 -2	.1019 -1	.1597	5.032	.2996 -1	27.72	2.245451	78.111	11.24	.4134	30.54	5.042	6.056	.5586 -1	.2911 -1
5.14	.1608 -2	.1010 -1	.1591	5.042	.2973 -1	27.94	2.246148	78.201	11.22	.4133	30.66	5.045	6.076	.5543 -1	.2900 -1
5.15	.1589 -2	.1002 -1	.1586	5.052	.2951 -1	28.16	2.246842	78.290	11.20	.4132	30.78	5.048	6.096	.5501 -1	.2889 -1
5.16	.1571 -2	.9939 -2	.1581	5.062	.2929 -1	28.38	2.247532	78.379	11.18	.4130	30.90	5.051	6.117	.5460 -1	.2878 -1
5.17	.1553 -2	.9858 -2	.1576	5.072	.2907 -1	28.60	2.248219	78.468	11.15	.4129	31.02	5.054	6.137	.5418 -1	.2867 -1
5.18	.1536 -2	.9778 -2	.1571	5.083	.2885 -1	28.83	2.248903	78.556	11.13	.4128	31.14	5.058	6.157	.5377 -1	.2856 -1
5.19	.1518 -2	.9699 -2	.1566	5.093	.2863 -1	29.06	2.249583	78.645	11.11	.4126	31.26	5.061	6.177	.5337 -1	.2845 -1
5.20	.1501 -2	.9620 -2	.1561	5.103	.2842 -1	29.28	2.250260	78.733	11.09	.4125	31.38	5.064	6.197	.5297 -1	.2834 -1
5.21	.1484 -2	.9543 -2	.1555	5.113	.2821 -1	29.51	2.250934	78.820	11.07	.4124	31.50	5.067	6.217	.5257 -1	.2824
5.22	.1468 -2	.9466 -2	.1550	5.123	.2799 -1	29.74	2.251604	78.908	11.04	.4123	31.62	5.070	6.238	.5217 -1	.281[illegible]
5.23	.1451 -2	.9389 -2	.1545	5.134	.2778 -1	29.98	2.252271	78.995	11.02	.4121	31.75	5.073	6.258	.5178 -1	.280[illegible]
5.24	.1435 -2	.9314 -2	.1540	5.144	.2758 -1	30.21	2.252935	79.081	11.00	.4120	31.87	5.076	6.278	.5139 -1	.279[illegible]
5.25	.1419 -2	.9239 -2	.1536	5.154	.2737 -1	30.45	2.253596	79.167	10.98	.4119	31.99	5.079	6.299	.5100 -1	.2782
5.26	.1403 -2	.9165 -2	.1531	5.164	.2717 -1	30.68	2.254254	79.254	10.96	.4118	32.11	5.082	6.319	.5062 -1	.2771 -1
5.27	.1387 -2	.9092 -2	.1526	5.174	.2697 -1	30.92	2.254908	79.340	10.94	.4116	32.24	5.085	6.340	.5024 -1	.2761 -1
5.28	.1372 -2	.9019 -2	.1521	5.184	.2677 -1	31.16	2.255559	79.426	10.92	.4115	32.36	5.088	6.360	.4987 -1	.2750 -1
5.29	.1356 -2	.8947 -2	.1516	5.195	.2657 -1	31.41	2.256207	79.511	10.90	.4114	32.48	5.090	6.381	.4950 -1	.2740 -1
5.30	.1341 -2	.8875 -2	.1511	5.205	.2637 -1	31.65	2.256852	79.597	10.88	.4113	32.61	5.093	6.401	.4913 -1	.2730 -1
5.31	.1326 -2	.8805 -2	.1506	5.215	.2617 -1	31.89	2.257494	79.681	10.86	.4112	32.73	5.096	6.422	.4876 -1	.2720 -1
5.32	.1311 -2	.8734 -2	.1501	5.225	.2598 -1	32.14	2.258133	79.765	10.83	.4110	32.85	5.099	6.443	.4840 -1	.2710 -1
5.33	.1297 -2	.8665 -2	.1497	5.235	.2579 -1	32.39	2.258769	79.850	10.81	.4109	32.98	5.102	6.464	.4804 -1	.2700 -1
5.34	.1282 -2	.8596 -2	.1492	5.246	.2560 -1	32.64	2.259401	79.934	10.79	.4108	33.10	5.105	6.484	.4768 -1	.2690 -1
5.35	.1268 -2	.8528 -2	.1487	5.256	.2541 -1	32.89	2.260031	80.018	10.77	.4107	33.23	5.108	6.505	.4733 -1	.2680 -1
5.36	.1254 -2	.8461 -2	.1482	5.266	.2522 -1	33.14	2.260658	80.101	10.75	.4106	33.35	5.111	6.526	.4697 -1	.2670 -1
5.37	.1240 -2	.8394 -2	.1478	5.276	.2504 -1	33.40	2.261281	80.185	10.73	.4104	33.48	5.113	6.547	.4663 -1	.2660 -1
5.38	.1227 -2	.8327 -2	.1473	5.286	.2485 -1	33.66	2.261902	80.268	10.71	.4103	33.60	5.116	6.568	.4628 -1	.2650 -1
5.39	.1213 -2	.8262 -2	.1468	5.296	.2467 -1	33.91	2.262520	80.351	10.69	.4102	33.73	5.119	6.589	.4594 -1	.2641 -1
5.40	.1200 -2	.8197 -2	.1464	5.307	.2449 -1	34.17	2.263135	80.434	10.67	.4101	33.85	5.122	6.610	.4560 -1	.2631 -1
5.41	.1187 -2	.8132 -2	.1459	5.317	.2431 -1	34.44	2.263747	80.515	10.65	.4100	33.98	5.125	6.631	.4526 -1	.2621 -1
5.42	.1174 -2	.8068 -2	.1454	5.327	.2413 -1	34.70	2.264356	80.597	10.63	.4099	34.11	5.127	6.652	.4493 -1	.2612 -1
5.43	.1161 -2	.8005 -2	.1450	5.337	.2395 -1	34.97	2.264962	80.680	10.61	.4098	34.23	5.130	6.673	.4460 -1	.2602 -1
5.44	.1148 -2	.7942 -2	.1445	5.347	.2378 -1	35.23	2.265566	80.760	10.59	.4096	34.36	5.133	6.694	.4427 -1	.2593 -1
5.45	.1135 -2	.7880 -2	.1441	5.357	.2361 -1	35.50	2.266166	80.842	10.57	.4095	34.49	5.136	6.715	.4395 -1	.2583 -1
5.46	.1123 -2	.7818 -2	.1436	5.368	.2344 -1	35.77	2.266764	80.923	10.55	.4094	34.61	5.138	6.737	.4362 -1	.2574 -1
5.47	.1111 -2	.7757 -2	.1432	5.378	.2326 -1	36.04	2.267359	81.004	10.53	.4093	34.74	5.141	6.758	.4330 -1	.2565 -1
5.48	.1099 -2	.7697 -2	.1427	5.388	.2309 -1	36.32	2.267951	81.084	10.51	.4092	34.87	5.144	6.779	.4299 -1	.2556 -1
5.49	.1087 -2	.7637 -2	.1423	5.398	.2293 -1	36.59	2.268540	81.165	10.50	.4091	35.00	5.146	6.800	.4267 -1	.2546 -1
5.50	.1075 -2	.7578 -2	.1418	5.408	.2276 -1	36.87	2.269127	81.245	10.48	.4090	35.13	5.149	6.822	.4236 -1	.2537 -1
5.51	.1063 -2	.7519 -2	.1414	5.418	.2260 -1	37.15	2.269711	81.324	10.46	.4089	35.25	5.152	6.843	.4205 -1	.2528 -1
5.52	.1052 -2	.7460 -2	.1410	5.429	.2243 -1	37.43	2.270292	81.404	10.44	.4088	35.38	5.154	6.865	.4175 -1	.2519 -1
5.53	.1040 -2	.7403 -2	.1405	5.439	.2227 -1	37.71	2.270870	81.484	10.42	.4086	35.51	5.157	6.886	.4144 -1	.2510 -1
5.54	.1029 -2	.7345 -2	.1401	5.449	.2211 -1	38.00	2.271446	81.563	10.40	.4085	35.64	5.159	6.908	.4114 -1	.2501 -1
5.55	.1018 -2	.7289 -2	.1397	5.459	.2195 -1	38.28	2.272019	81.641	10.38	.4084	35.77	5.162	6.929	.4084 -1	.2492 -1
5.56	.1007 -2	.7232 -2	.1392	5.469	.2179 -1	38.57	2.272589	81.720	10.36	.4083	35.90	5.165	6.951	.4054 -1	.2483 -1
5.57	.9961 -3	.7177 -2	.1388	5.479	.2163 -1	38.86	2.273157	81.798	10.34	.4082	36.03	5.167	6.973	.4025 -1	.2475 -1
5.58	.9853 -3	.7121 -2	.1384	5.490	.2148 -1	39.15	2.273722	81.876	10.32	.4081	36.16	5.170	6.994	.3996 -1	.2466 -1
5.59	.9748 -3	.7067 -2	.1379	5.500	.2132 -1	39.44	2.274285	81.955	10.31	.4080	36.29	5.172	7.016	.3967 -1	.2457 -1
5.60	.9643 -3	.7012 -2	.1375	5.510	.2117 -1	39.74	2.274844	82.032	10.29	.4079	36.42	5.175	7.038	.3938 -1	.2449 -1
5.61	.9540 -3	.6959 -2	.1371	5.520	.2102 -1	40.04	2.275402	82.109	10.27	.4078	36.55	5.177	7.060	.3910 -1	.2440 -1
5.62	.9438 -3	.6905 -2	.1367	5.530	.2087 -1	40.34	2.275957	82.187	10.25	.4077	36.68	5.180	7.082	.3882 -1	.2431 -1
5.63	.9337 -3	.6853 -2	.1363	5.540	.2072 -1	40.64	2.276509	82.263	10.23	.4076	36.81	5.182	7.103	.3854 -1	.2423 -1
5.64	.9237 -3	.6800 -2	.1358	5.551	.2057 -1	40.94	2.277058	82.340	10.21	.4075	36.94	5.185	7.125	.3826 -1	.241[illegible]
5.65	.9139 -3	.6748 -2	.1354	5.561	.2042 -1	41.25	2.277606	82.417	10.20	.4074	37.08	5.187	7.147	.3798 -1	.2[illegible]
5.66	.9041 -3	.6697 -2	.1350	5.571	.2028 -1	41.55	2.278150	82.493	10.18	.4073	37.21	5.190	7.169	.3771 -1	.2[illegible]
5.67	.8945 -3	.6646 -2	.1346	5.581	.2013 -1	41.86	2.278692	82.569	10.16	.4072	37.34	5.192	7.191	.3744 -1	.2[illegible]
5.68	.8850 -3	.6596 -2	.1342	5.591	.1999 -1	42.17	2.279232	82.645	10.14	.4071	37.47	5.195	7.213	.3717 -1	.23[illegible]
5.69	.8756 -3	.6545 -2	.1338	5.601	.1984 -1	42.48	2.279769	82.720	10.12	.4070	37.61	5.197	7.236	.3691 -1	.2372
5.70	.8663 -3	.6496 -2	.1334	5.612	.1970 -1	42.80	2.280304	82.795	10.10	.4069	37.74	5.200	7.258	.3664 -1	.2364 -1
5.71	.8572 -3	.6447 -2	.1330	5.622	.1956 -1	43.11	2.280836	82.871	10.09	.4068	37.87	5.202	7.280	.3638 -1	.2356 -1
5.72	.8481 -3	.6398 -2	.1326	5.632	.1942 -1	43.43	2.281366	82.946	10.07	.4067	38.00	5.205	7.302	.3612 -1	.2348 -1
5.73	.8392 -3	.6350 -2	.1322	5.642	.1929 -1	43.75	2.281894	83.020	10.05	.4066	38.14	5.207	7.324	.3586 -1	.2340 -1
5.74	.8303 -3	.6302 -2	.1318	5.652	.1915 -1	44.07	2.282419	83.095	10.03	.4065	38.27	5.209	7.347	.3561 -1	.2332 -1

TABLE II.—SUPERSONIC FLOW—Continued

$\gamma=7/5$

M or M_1	$\frac{p}{p_t}$	$\frac{\rho}{\rho_t}$	$\frac{T}{T_t}$	β	$\frac{q}{p_t}$	$\frac{A}{A_*}$	$\frac{V}{a_*}$	ν	μ	M_2	$\frac{p_2}{p_1}$	$\frac{\rho_2}{\rho_1}$	$\frac{T_2}{T_1}$	$\frac{p_{t_2}}{p_{t_1}}$	$\frac{p_1}{p_{t_2}}$
5.75	.8216 -3	.6254 -2	.1314	5.662	.1902 -1	44.40	2.282942	83.169	10.02	.4064	38.41	5.212	7.369	.3536 -1	.2324 -1
5.76	.8130 -3	.6207 -2	.1310	5.673	.1888 -1	44.72	2.283462	83.243	9.996	.4063	38.54	5.214	7.392	.3510 -1	.2316 -1
5.77	.8044 -3	.6161 -2	.1306	5.683	.1875 -1	45.05	2.283980	83.317	9.980	.4062	38.68	5.217	7.414	.3486 -1	.2308 -1
5.78	.7960 -3	.6114 -2	.1302	5.693	.1862 -1	45.38	2.284496	83.391	9.963	.4061	38.81	5.219	7.436	.3461 -1	.2300 -1
5.79	.7876 -3	.6069 -2	.1298	5.703	.1848 -1	45.72	2.285009	83.463	9.946	.4060	38.94	5.221	7.459	.3436 -1	.2292 -1
5.80	.7794 -3	.6023 -2	.1294	5.713	.1835 -1	46.05	2.285520	83.537	9.928	.4059	39.08	5.224	7.481	.3412 -1	.2284 -1
5.81	.7713 -3	.5978 -2	.1290	5.723	.1823 -1	46.39	2.286029	83.609	9.911	.4059	39.22	5.226	7.504	.3388 -1	.2277 -1
5.82	.7632 -3	.5934 -2	.1286	5.733	.1810 -1	46.72	2.286535	83.683	9.894	.4058	39.35	5.228	7.527	.3364 -1	.2269 -1
5.83	.7553 -3	.5889 -2	.1282	5.744	.1797 -1	47.07	2.287040	83.755	9.877	.4057	39.49	5.231	7.549	.3340 -1	.2261 -1
5.84	.7474 -3	.5846 -2	.1279	5.754	.1784 -1	47.41	2.287542	83.827	9.860	.4056	39.62	5.233	7.572	.3317 -1	.2254 -1
5.85	.7396 -3	.5802 -2	.1275	5.764	.1772 -1	47.75	2.288041	83.899	9.842	.4055	39.76	5.235	7.595	.3293 -1	.2246 -1
5.86	.7320 -3	.5759 -2	.1271	5.774	.1760 -1	48.10	2.288539	83.971	9.826	.4054	39.90	5.237	7.618	.3270 -1	.2238 -1
5.87	.7244 -3	.5716 -2	.1267	5.784	.1747 -1	48.45	2.289034	84.042	9.809	.4053	40.03	5.240	7.640	.3247 -1	.2231 -1
5.88	.7169 -3	.5674 -2	.1263	5.794	.1735 -1	48.80	2.289527	84.114	9.792	.4052	40.17	5.242	7.663	.3225 -1	.2223 -1
5.89	.7095 -3	.5632 -2	.1260	5.804	.1723 -1	49.15	2.290018	84.185	9.775	.4051	40.31	5.244	7.686	.3202 -1	.2216 -1
5.90	.7021 -3	.5590 -2	.1256	5.815	.1711 -1	49.51	2.290507	84.257	9.758	.4050	40.45	5.246	7.709	.3180 -1	.2208 -1
5.91	.6949 -3	.5549 -2	.1252	5.825	.1699 -1	49.86	2.290993	84.327	9.742	.4049	40.58	5.249	7.732	.3157 -1	.2201 -1
5.92	.6877 -3	.5508 -2	.1249	5.835	.1687 -1	50.22	2.291477	84.398	9.725	.4049	40.72	5.251	7.755	.3135 -1	.2194 -1
5.93	.6807 -3	.5468 -2	.1245	5.845	.1676 -1	50.59	2.291960	84.468	9.708	.4048	40.86	5.253	7.778	.3113 -1	.2186 -1
5.94	.6737 -3	.5428 -2	.1241	5.855	.1664 -1	50.95	2.292440	84.539	9.692	.4047	41.00	5.255	7.801	.3092 -1	.2179 -1
5.95	.6668 -3	.5388 -2	.1238	5.865	.1652 -1	51.32	2.292918	84.609	9.675	.4046	41.14	5.257	7.824	.3070 -1	.2172 -1
5.96	.6599 -3	.5348 -2	.1234	5.876	.1641 -1	51.68	2.293394	84.679	9.659	.4045	41.28	5.260	7.847	.3049 -1	.2165 -1
5.97	.6532 -3	.5309 -2	.1230	5.886	.1630 -1	52.05	2.293867	84.748	9.643	.4044	41.41	5.262	7.871	.3028 -1	.2157 -1
5.98	.6465 -3	.5270 -2	.1227	5.896	.1618 -1	52.43	2.294339	84.817	9.626	.4043	41.55	5.264	7.894	.3007 -1	.2150 -1
5.99	.6399 -3	.5232 -2	.1223	5.906	.1607 -1	52.80	2.294809	84.887	9.610	.4042	41.69	5.266	7.917	.2986 -1	.2143 -1
6.00	.6334 -3	.5194 -2	.1220	5.916	.1596 -1	53.18	2.295276	84.955	9.594	.4042	41.83	5.268	7.941	.2965 -1	.2136 -1
6.01	.6269 -3	.5156 -2	.1216	5.926	.1585 -1	53.56	2.295742	85.025	9.578	.4041	41.97	5.270	7.964	.2945 -1	.2129 -1
6.02	.6205 -3	.5118 -2	.1212	5.936	.1574 -1	53.94	2.296205	85.093	9.562	.4040	42.11	5.273	7.987	.2924 -1	.2122 -1
6.03	.6142 -3	.5081 -2	.1209	5.947	.1563 -1	54.32	2.296667	85.162	9.546	.4039	42.25	5.275	8.011	.2904 -1	.2115 -1
6.04	.6080 -3	.5044 -2	.1205	5.957	.1553 -1	54.71	2.297126	85.230	9.530	.4038	42.40	5.277	8.034	.2884 -1	.2108 -1
6.05	.6018 -3	.5008 -2	.1202	5.967	.1542 -1	55.10	2.297583	85.297	9.514	.4037	42.54	5.279	8.058	.2864 -1	.2101 -1
6.06	.5957 -3	.4971 -2	.1198	5.977	.1531 -1	55.49	2.298039	85.366	9.498	.4037	42.68	5.281	8.081	.2844 -1	.2094 -1
6.07	.5897 -3	.4935 -2	.1195	5.987	.1521 -1	55.88	2.298492	85.433	9.482	.4036	42.82	5.283	8.105	.2825 -1	.2088 -1
6.08	.5838 -3	.4900 -2	.1191	5.997	.1511 -1	56.28	2.298944	85.500	9.467	.4035	42.96	5.285	8.129	.2806 -1	.2081 -1
6.09	.5779 -3	.4864 -2	.1188	6.007	.1500 -1	56.68	2.299393	85.568	9.451	.4034	43.10	5.287	8.152	.2786 -1	.2074 -1
6.10	.5721 -3	.4829 -2	.1185	6.017	.1490 -1	57.08	2.299841	85.635	9.435	.4033	43.25	5.289	8.176	.2767 -1	.2067 -1
6.11	.5663 -3	.4795 -2	.1181	6.028	.1480 -1	57.48	2.300286	85.702	9.420	.4033	43.39	5.291	8.200	.2748 -1	.2061 -1
6.12	.5606 -3	.4760 -2	.1178	6.038	.1470 -1	57.88	2.300730	85.768	9.404	.4032	43.53	5.293	8.223	.2730 -1	.2054 -1
6.13	.5550 -3	.4726 -2	.1174	6.048	.1460 -1	58.29	2.301172	85.834	9.389	.4031	43.67	5.295	8.247	.2711 -1	.2047 -1
6.14	.5494 -3	.4692 -2	.1171	6.058	.1450 -1	58.70	2.301612	85.901	9.373	.4030	43.82	5.297	8.271	.2692 -1	.2041 -1
6.15	.5439 -3	.4658 -2	.1168	6.068	.1440 -1	59.11	2.302050	85.967	9.358	.4029	43.96	5.299	8.295	.2674 -1	.2034 -1
6.16	.5385 -3	.4625 -2	.1164	6.078	.1430 -1	59.53	2.302486	86.033	9.343	.4029	44.10	5.301	8.319	.2656 -1	.2028 -1
6.17	.5331 -3	.4592 -2	.1161	6.088	.1421 -1	59.94	2.302920	86.099	9.327	.4028	44.25	5.303	8.343	.2638 -1	.2021 -1
6.18	.5278 -3	.4559 -2	.1158	6.099	.1411 -1	60.36	2.303353	86.164	9.312	.4027	44.39	5.305	8.367	.2620 -1	.2015 -1
6.19	.5225 -3	.4527 -2	.1154	6.109	.1402 -1	60.79	2.303783	86.229	9.297	.4026	44.54	5.307	8.391	.2602 -1	.2008 -1
6.20	.5173 -3	.4495 -2	.1151	6.119	.1392 -1	61.21	2.304212	86.295	9.282	.4025	44.68	5.309	8.415	.2584 -1	.2002 -1
6.21	.5122 -3	.4463 -2	.1148	6.129	.1383 -1	61.64	2.304639	86.360	9.267	.4025	44.82	5.311	8.439	.2567 -1	.1995 -1
6.22	.5071 -3	.4431 -2	.1144	6.139	.1373 -1	62.07	2.305064	86.424	9.252	.4024	44.97	5.313	8.464	.2550 -1	.1989 -1
6.23	.5021 -3	.4400 -2	.1141	6.149	.1364 -1	62.50	2.305487	86.490	9.237	.4023	45.12	5.315	8.488	.2532 -1	.1983 -1
6.24	.4971 -3	.4369 -2	.1138	6.159	.1355 -1	62.93	2.305908	86.554	9.222	.4022	45.26	5.317	8.512	.2515 -1	.1977 -1
6.25	.4922 -3	.4338 -2	.1135	6.169	.1346 -1	63.37	2.306328	86.618	9.207	.4022	45.41	5.319	8.536	.2498 -1	.1970 -1
6.26	.4874 -3	.4307 -2	.1132	6.180	.1337 -1	63.81	2.306746	86.683	9.192	.4021	45.55	5.321	8.561	.2482 -1	.1964 -1
6.27	.4825 -3	.4277 -2	.1128	6.190	.1328 -1	64.25	2.307162	86.746	9.177	.4020	45.70	5.323	8.585	.2465 -1	.1958 -1
6.28	.4778 -3	.4246 -2	.1125	6.200	.1319 -1	64.69	2.307576	86.810	9.163	.4019	45.84	5.325	8.610	.2448 -1	.1952 -1
6.29	.4731 -3	.4217 -2	.1122	6.210	.1310 -1	65.14	2.307989	86.874	9.148	.4019	45.99	5.327	8.634	.2432 -1	.1945 -1
6.30	.4684 -3	.4187 -2	.1119	6.220	.1302 -1	65.59	2.308400	86.937	9.133	.4018	46.14	5.329	8.658	.2416 -1	.1939 -1
6.31	.4638 -3	.4158 -2	.1116	6.230	.1293 -1	66.04	2.308809	87.000	9.119	.4017	46.29	5.331	8.683	.2399 -1	.1933 -1
6.32	.4593 -3	.4128 -2	.1113	6.240	.1284 -1	66.50	2.309216	87.063	9.104	.4016	46.43	5.332	8.708	.2383 -1	.1927 -1
6.33	.4548 -3	.4100 -2	.1109	6.251	.1276 -1	66.95	2.309622	87.126	9.090	.4016	46.58	5.334	8.732	.2367 -1	.1921 -1
6.34	.4504 -3	.4071 -2	.1106	6.261	.1267 -1	67.41	2.310026	87.189	9.075	.4015	46.73	5.336	8.757	.2352 -1	.1915 -1
6.35	.4460 -3	.4042 -2	.1103	6.271	.1259 -1	67.88	2.310428	87.251	9.061	.4014	46.88	5.338	8.781	.2336 -1	.1909 -1
6.36	.4416 -3	.4014 -2	.1100	6.281	.1250 -1	68.34	2.310828	87.315	9.046	.4014	47.02	5.340	8.806	.2320 -1	.1903 -1
6.37	.4373 -3	.3986 -2	.1097	6.291	.1242 -1	68.81	2.311227	87.376	9.032	.4013	47.17	5.342	8.831	.2305 -1	.1897 -1
6.38	.4331 -3	.3958 -2	.1094	6.301	.1234 -1	69.28	2.311625	87.438	9.018	.4012	47.32	5.344	8.856	.2290 -1	.1891 -1
6.39	.4288 -3	.3931 -2	.1091	6.311	.1226 -1	69.75	2.312020	87.499	9.004	.4011	47.47	5.345	8.881	.2274 -1	.1886 -1
6.40	.4247 -3	.3904 -2	.1088	6.321	.1218 -1	70.23	2.312414	87.561	8.989	.4011	47.62	5.347	8.905	.2259 -1	.1880 -1
6.41	.4206 -3	.3877 -2	.1085	6.332	.1210 -1	70.57	2.312806	87.623	8.975	.4010	47.77	5.349	8.930	.2244 -1	.1874 -1
6.42	.4165 -3	.3850 -2	.1082	6.342	.1202 -1	71.19	2.313197	87.684	8.961	.4009	47.92	5.351	8.955	.2230 -1	.1868 -1
6.43	.4125 -3	.3823 -2	.1079	6.352	.1194 -1	71.67	2.313586	87.745	8.947	.4009	48.07	5.353	8.980	.2215 -1	.1862 -1
6.44	.4085 -3	.3797 -2	.1076	6.362	.1186 -1	72.16	2.313973	87.806	8.933	.4008	48.22	5.354	9.005	.2200 -1	.1857 -1
6.45	.4045 -3	.3771 -2	.1073	6.372	.1178 -1	72.65	2.314359	87.867	8.919	.4007	48.37	5.356	9.031	.2186 -1	.1851 -1
6.46	.4006 -3	.3745 -2	.1070	6.382	.1170 -1	73.14	2.314743	87.927	8.905	.4007	48.52	5.358	9.056	.2171 -1	.1845 -1
6.47	.3968 -3	.3719 -2	.1067	6.392	.1163 -1	73.63	2.315126	87.988	8.891	.4006	48.67	5.360	9.081	.2157 -1	.1840 -1
6.48	.3930 -3	.3693 -2	.1064	6.402	.1155 -1	74.13	2.315507	88.048	8.877	.4005	48.82	5.362	9.106	.2143 -1	.1834 -1
6.49	.3892 -3	.3668 -2	.1061	6.412	.1148 -1	74.63	2.315886	88.108	8.864	.4004	48.97	5.363	9.131	.2129 -1	.1828 -1
6.50	.3855 -3	.3643 -2	.1058	6.423	.1140 -1	75.13	2.316264	88.169	8.850	.4004	49.13	5.365	9.156	.2115 -1	.1823 -1
6.51	.3818 -3	.3618 -2	.1055	6.433	.1133 -1	75.65	2.316640	88.228	8.836	.4003	49.28	5.367	9.182	.2101 -1	.1817 -1
6.52	.3781 -3	.3593 -2	.1052	6.443	.1125 -1	76.15	2.317015	88.288	8.823	.4002	49.43	5.369	9.207	.2087 -1	.1812 -1
6.53	.3745 -3	.3568 -2	.1050	6.453	.1118 -1	76.66	2.317388	88.347	8.809	.4002	49.58	5.370	9.232	.2073 -1	.1806 -1
6.54	.3709 -3	.3544 -2	.1047	6.463	.1111 -1	77.18	2.317760	88.406	8.795	.4001	49.73	5.372	9.258	.2060 -1	.1801 -1
6.55	.3674 -3	.3520 -2	.1044	6.473	.1103 -1	77.69	2.318130	88.466	8.782	.4000	49.89	5.374	9.283	.2047 -1	.1795 -1
6.56	.3639 -3	.3496 -2	.1041	6.483	.1096 -1	78.21	2.318499	88.525	8.768	.4000	50.04	5.375	9.309	.2033 -1	.1790 -1
6.57	.3604 -3	.3472 -2	.1038	6.493	.1089 -1	78.74	2.318866	88.584	8.755	.3999	50.19	5.377	9.334	.2020 -1	.1784 -1
6.58	.3570 -3	.3449 -2	.1035	6.504	.1082 -1	79.26	2.319232	88.642	8.741	.3999	50.35	5.379	9.360	.2007 -1	.1779 -1
6.59	.3536 -3	.3425 -2	.1032	6.514	.1075 -1	79.79	2.319596	88.701	8.728	.3998	50.50	5.381	9.386	.1994 -1	.1774 -1
6.60	.3503 -3	.3402 -2	.1030	6.524	.1068 -1	80.32	2.319959	88.760	8.715	.3997	50.65	5.382	9.411	.1981 -1	.1768 -1
6.61	.3470 -3	.3379 -2	.1027	6.534	.1061 -1	80.86	2.320320	88.818	8.702	.3997	50.81	5.384	9.437	.1968 -1	.1763 -1
6.62	.3437 -3	.3356 -2	.1024	6.544	.1054 -1	81.40	2.320679	88.876	8.688	.3996	50.96	5.386	9.463	.1955 -1	.1758 -1
6.63	.3404 -3	.3333 -2	.1021	6.554	.1048 -1	81.94	2.321038	88.934	8.675	.3995	51.12	5.387	9.488	.1943 -1	.1753 -1
6.64	.3372 -3	.3311 -2	.1019	6.564	.1041 -1	82.48	2.321395	88.991	8.662	.3995	51.27	5.389	9.514	.1930 -1	.1747 -1

TABLE II.—SUPERSONIC FLOW—Continued

$\gamma=7/5$

M or M_1	$\frac{p}{p_t}$	$\frac{\rho}{\rho_t}$	$\frac{T}{T_t}$	β	$\frac{q}{p_t}$	$\frac{A}{A_*}$	$\frac{V}{a_*}$	ν	μ	M_2	$\frac{p_2}{p_1}$	$\frac{\rho_2}{\rho_1}$	$\frac{T_2}{T_1}$	$\frac{p_{t_2}}{p_{t_1}}$	$\frac{p_1}{p_{t_2}}$
6.65	.3341^{-3}	.3289^{-2}	.1016	6.574	.1034^{-1}	83.03	2.321750	89.049	8.649	.3994	51.43	5.391	9.540	.1918^{-1}	.1742^{-1}
6.66	.3309^{-3}	.3267^{-2}	.1013	6.584	.1028^{-1}	83.58	2.322104	89.106	8.636	.3993	51.58	5.392	9.566	.1905^{-1}	.1737^{-1}
6.67	.3278^{-3}	.3245^{-2}	.1010	6.595	.1021^{-1}	84.13	2.322456	89.164	8.623	.3993	51.74	5.394	9.592	.1893^{-1}	.1732^{-1}
6.68	.3247^{-3}	.3223^{-2}	.1008	6.605	.1014^{-1}	84.68	2.322807	89.221	8.610	.3992	51.89	5.395	9.618	.1881^{-1}	.1727^{-1}
6.69	.3217^{-3}	.3201^{-2}	.1005	6.615	.1008^{-1}	85.24	2.323157	89.278	8.597	.3992	52.05	5.397	9.644	.1869^{-1}	.1721^{-1}
6.70	.3187^{-3}	.3180^{-2}	.1002	6.625	.1001^{-1}	85.80	2.323505	89.335	8.584	.3991	52.21	5.399	9.670	.1857^{-1}	.1716^{-1}
6.71	.3157^{-3}	.3158^{-2}	.9995^{-1}	6.635	.9950^{-2}	86.37	2.323852	89.391	8.571	.3990	52.36	5.400	9.696	.1845^{-1}	.1711^{-1}
6.72	.3127^{-3}	.3137^{-2}	.9968^{-1}	6.645	.9886^{-2}	86.94	2.324198	89.448	8.558	.3990	52.52	5.402	9.722	.1833^{-1}	.1706^{-1}
6.73	.3098^{-3}	.3116^{-2}	.9942^{-1}	6.655	.9823^{-2}	87.51	2.324542	89.504	8.545	.3989	52.68	5.403	9.748	.1821^{-1}	.1701^{-1}
6.74	.3069^{-3}	.3096^{-2}	9915^{-1}	6.665	.9761^{-2}	88.08	2.324884	89.561	8.532	.3988	52.83	5.405	9.775	.1810^{-1}	.1696^{-1}
6.75	.3041^{-3}	.3075^{-2}	.9889^{-1}	6.676	.9699^{-2}	88.66	2.325226	89.617	8.520	.3988	52.99	5.407	9.801	.1798^{-1}	.1691^{-1}
6.76	.3013^{-3}	.3055^{-2}	.9862^{-1}	6.686	.9637^{-2}	89.24	2.325566	89.673	8.507	.3987	53.15	5.408	9.827	.1786^{-1}	.1686^{-1}
6.77	.2985^{-3}	.3034^{-2}	.9836^{-1}	6.696	.9576^{-2}	89.82	2.325904	89.729	8.494	.3987	53.31	5.410	9.853	.1775^{-1}	.1681^{-1}
6.78	.2957^{-3}	.3014^{-2}	.9810^{-1}	6.706	.9515^{-2}	90.41	2.326242	89.784	8.482	.3986	53.46	5.411	9.880	.1764^{-1}	.1677^{-1}
6.79	.2930^{-3}	.2994^{-2}	.9784^{-1}	6.716	.9454^{-2}	91.00	2.326578	89.840	8.469	.3986	53.62	5.413	9.906	.1753^{-1}	.1671^{-1}
6.80	.2902^{-3}	.2974^{-2}	.9758^{-1}	6.726	.9395^{-2}	91.59	2.326912	89.895	8.457	.3985	53.78	5.415	9.933	.1741^{-1}	.1667^{-1}
6.81	.2876^{-3}	.2955^{-2}	.9732^{-1}	6.736	.9335^{-2}	92.19	2.327245	89.950	8.444	.3984	53.94	5.416	9.959	.1730^{-1}	.1662^{-1}
6.82	.2849^{-3}	.2935^{-2}	.9706^{-1}	6.746	.9276^{-2}	92.79	2.327577	90.005	8.432	.3984	54.10	5.418	9.986	.1719^{-1}	.1657^{-1}
6.83	.2823^{-3}	.2916^{-2}	.9681^{-1}	6.756	.9218^{-2}	93.39	2.327908	90.060	8.419	.3983	54.26	5.419	10.01	.1709^{-1}	.1652^{-1}
6.84	.2797^{-3}	.2897^{-2}	.9655^{-1}	6.767	.9160^{-2}	94.00	2.328237	90.116	8.407	.3983	54.42	5.421	10.04	.1698^{-1}	.1647^{-1}
6.85	.2771^{-3}	.2878^{-2}	.9630^{-1}	6.777	.9102^{-2}	94.61	2.328565	90.170	8.394	.3982	54.58	5.422	10.07	.1687^{-1}	.1643^{-1}
6.86	.2746^{-3}	.2859^{-2}	.9604^{-1}	6.787	.9045^{-2}	95.22	2.328892	90.225	8.382	.3981	54.74	5.424	10.09	.1676^{-1}	.1638^{-1}
6.87	.2720^{-3}	.2840^{-2}	.9579^{-1}	6.797	.8988^{-2}	95.83	2.329217	90.279	8.370	.3981	54.90	5.425	10.12	.1666^{-1}	.1633^{-1}
6.88	.2696^{-3}	.2821^{-2}	.9554^{-1}	6.807	.8931^{-2}	96.45	2.329541	90.333	8.357	.3980	55.06	5.427	10.15	.1655^{-1}	.1628^{-1}
6.89	.2671^{-3}	.2803^{-2}	.9529^{-1}	6.817	.8875^{-2}	97.08	2.329864	90.387	8.345	.3980	55.22	5.428	10.17	.1645^{-1}	.1624^{-1}
6.90	.2646^{-3}	.2785^{-2}	.9504^{-1}	6.827	.8820^{-2}	97.70	2.330186	90.441	8.333	.3979	55.38	5.430	10.20	.1634^{-1}	.1619^{-1}
6.91	.2622^{-3}	.2766^{-2}	.9479^{-1}	6.837	.8764^{-2}	98.33	2.330506	90.495	8.321	.3979	55.54	5.431	10.23	.1624^{-1}	.1614^{-1}
6.92	.2598^{-3}	.2748^{-2}	.9454^{-1}	6.847	.8710^{-2}	98.96	2.330825	90.549	8.309	.3978	55.70	5.433	10.25	.1614^{-1}	.1610^{-1}
6.93	.2575^{-3}	.2730^{-2}	.9430^{-1}	6.857	.8655^{-2}	99.60	2.331143	90.602	8.297	.3977	55.86	5.434	10.28	.1604^{-1}	.1605^{-1}
6.94	.2551^{-3}	.2713^{-2}	.9405^{-1}	6.868	.8601^{-2}	100.2	2.331460	90.655	8.285	.3977	56.02	5.436	10.31	.1594^{-1}	.1601^{-1}
6.95	.2528^{-3}	.2695^{-2}	.9380^{-1}	6.878	.8548^{-2}	100.9	2.331775	90.709	8.273	.3976	56.19	5.437	10.33	.1584^{-1}	.1596^{-1}
6.96	.2505^{-3}	.2677^{-2}	.9356^{-1}	6.888	.8495^{-2}	101.5	2.332089	90.762	8.261	.3976	56.35	5.439	10.36	.1574^{-1}	.1592^{-1}
6.97	.2482^{-3}	.2660^{-2}	.9332^{-1}	6.898	.8442^{-2}	102.2	2.332402	90.815	8.249	.3975	56.51	5.440	10.39	.1564^{-1}	.1587^{-1}
6.98	.2460^{-3}	.2643^{-2}	.9307^{-1}	6.908	.8389^{-2}	102.8	2.332714	90.867	8.237	.3975	56.67	5.442	10.42	.1554^{-1}	.1582^{-1}
6.99	.2438^{-3}	.2626^{-2}	.9283^{-1}	6.918	.8337^{-2}	103.5	2.333024	90.920	8.225	.3974	56.84	5.443	10.44	.1545^{-1}	.1578^{-1}
7.00	.2416^{-3}	.2609^{-2}	.9259^{-1}	6.928	.8286^{-2}	104.1	2.333333	90.973	8.213	.3974	57.00	5.444	10.47	.1535^{-1}	.1574^{-1}
7.01	.2394^{-3}	.2592^{-2}	.9235^{-1}	6.938	.8234^{-2}	104.8	2.333641	91.026	8.201	.3973	57.16	5.446	10.50	.1526^{-1}	.1569^{-1}
7.02	.2372^{-3}	.2575^{-2}	.9211^{-1}	6.948	.8183^{-2}	105.5	2.333948	91.078	8.190	.3973	57.33	5.447	10.52	.1516^{-1}	.1565^{-1}
7.03	.2351^{-3}	.2559^{-2}	.9188^{-1}	6.959	.8133^{-2}	106.1	2.334254	91.130	8.178	.3972	57.49	5.449	10.55	.1507^{-1}	.1560^{-1}
7.04	.2330^{-3}	.2542^{-2}	.9164^{-1}	6.969	.8082^{-2}	106.8	2.334558	91.182	8.166	.3971	57.66	5.450	10.58	.1497^{-1}	.1556^{-1}
7.05	.2309^{-3}	.2526^{-2}	.9140^{-1}	6.979	.8032^{-2}	107.5	2.334862	91.234	8.155	.3971	57.82	5.452	10.61	.1488^{-1}	.1551^{-1}
7.06	.2288^{-3}	.2510^{-2}	.9117^{-1}	6.989	.7983^{-2}	108.2	2.335164	91.286	8.143	.3970	57.98	5.453	10.63	.1479^{-1}	.1547^{-1}
7.07	.2267^{-3}	.2494^{-2}	.9093^{-1}	6.999	.7934^{-2}	108.9	2.335465	91.337	8.131	.3970	58.15	5.454	10.66	.1470^{-1}	.1543^{-1}
7.08	.2247^{-3}	.2478^{-2}	.9070^{-1}	7.009	.7885^{-2}	109.5	2.335765	91.389	8.120	.3969	58.31	5.456	10.69	.1461^{-1}	.1538^{-1}
7.09	.2227^{-3}	.2462^{-2}	.9047^{-1}	7.019	.7857^{-2}	110.2	2.336063	91.440	8.108	.3969	58.48	5.457	10.72	.1452^{-1}	.1534^{-1}
7.10	.2207^{-3}	.2446^{-2}	.9024^{-1}	7.029	.7789^{-2}	110.9	2.336361	91.492	8.097	.3968	58.65	5.459	10.74	.1443^{-1}	.1530^{-1}
7.11	.2187^{-3}	.2430^{-2}	.9001^{-1}	7.039	.7741^{-2}	111.6	2.336657	91.543	8.085	.3968	58.81	5.460	10.77	.1434^{-1}	.1525^{-1}
7.12	.2168^{-3}	.2415^{-2}	.8978^{-1}	7.049	.7693^{-2}	112.3	2.336952	91.594	8.074	.3967	58.98	5.461	10.80	.1425^{-1}	.1521^{-1}
7.13	.2149^{-3}	.2400^{-2}	.8955^{-1}	7.060	.7646^{-2}	113.0	2.337246	91.645	8.062	.3967	59.14	5.463	10.83	.1416^{-1}	.1517^{-1}
7.14	.2130^{-3}	.2384^{-2}	.8932^{-1}	7.070	.7600^{-2}	113.7	2.337539	91.695	8.051	.3966	59.31	5.464	10.85	.1408^{-1}	.1513^{-1}
7.15	.2111^{-3}	.2369^{-2}	.8909^{-1}	7.080	.7553^{-2}	114.5	2.337831	91.746	8.040	.3966	59.48	5.465	10.88	.1399^{-1}	.1509^{-1}
7.16	.2092^{-3}	.2354^{-2}	.8886^{-1}	7.090	.7507^{-2}	115.2	2.338122	91.796	8.028	.3965	59.64	5.467	10.91	.1390^{-1}	.1504^{-1}
7.17	.2073^{-3}	.2339^{-2}	.8864^{-1}	7.100	.7461^{-2}	115.9	2.338412	91.847	8.017	.3965	59.81	5.468	10.94	.1382^{-1}	.1500^{-1}
7.18	.2055^{-3}	.2324^{-2}	.8841^{-1}	7.110	.7416^{-2}	116.6	2.338700	91.897	8.006	.3964	59.98	5.470	10.97	.1374^{-1}	.1496^{-1}
7.19	.2037^{-3}	.2310^{-2}	.8819^{-1}	7.120	.7371^{-2}	117.3	2.338988	91.947	7.995	.3964	60.15	5.471	10.99	.1365^{-1}	.1492^{-1}
7.20	.2019^{-3}	.2295^{-2}	.8797^{-1}	7.130	.7326^{-2}	118.1	2.339274	91.907	7.984	.3963	60.31	5.472	11.02	.1357^{-1}	.1488^{-1}
7.21	.2001^{-3}	.2281^{-2}	.8774^{-1}	7.140	.7281^{-2}	118.8	2.339559	92.047	7.972	.3963	60.48	5.474	11.05	.1349^{-1}	.1484^{-1}
7.22	.1983^{-3}	.2266^{-2}	.8752^{-1}	7.150	.7237^{-2}	119.6	2.339843	92.097	7.961	.3962	60.65	5.475	11.08	.1340^{-1}	.1480^{-1}
7.23	.1966^{-3}	.2252^{-2}	.8730^{-1}	7.161	.7194^{-2}	120.3	2.340127	92.146	7.950	.3962	60.82	5.476	11.11	.1332^{-1}	.1476^{-1}
7.24	.1949^{-3}	.2238^{-2}	.8708^{-1}	7.171	.7150^{-2}	121.0	2.340409	92.196	7.939	.3961	60.99	5.478	11.13	.1324^{-1}	.1472^{-1}
7.25	.1932^{-3}	.2224^{-2}	.8686^{-1}	7.181	.7107^{-2}	121.8	2.340690	92.245	7.928	.3961	61.16	5.479	11.16	.1316^{-1}	.1468^{-1}
7.26	.1915^{-3}	.2210^{-2}	.8664^{-1}	7.191	.7064^{-2}	122.5	2.340969	92.294	7.917	.3960	61.33	5.480	11.19	.1308^{-1}	.1464^{-1}
7.27	.1898^{-3}	.2196^{-2}	.8643^{-1}	7.201	.7021^{-2}	123.3	2.341248	92.343	7.906	.3960	61.50	5.481	11.22	.1300^{-1}	.1460^{-1}
7.28	.1881^{-3}	.2182^{-2}	.8621^{-1}	7.211	.6979^{-2}	124.1	2.341526	92.392	7.895	.3959	61.66	5.483	11.25	.1292^{-1}	.1456^{-1}
7.29	.1865^{-3}	.2169^{-2}	.8599^{-1}	7.221	.6937^{-2}	124.8	2.341803	92.441	7.884	.3959	61.83	5.484	11.28	.1285^{-1}	.1452^{-1}
7.30	.1848^{-3}	.2155^{-2}	.8578^{-1}	7.231	.6896^{-2}	125.6	2.342079	92.490	7.874	.3958	62.01	5.485	11.30	.1277^{-1}	.1448^{-1}
7.31	.1832^{-3}	.2142^{-2}	.8556^{-1}	7.241	.6854^{-2}	126.4	2.342353	92.538	7.863	.3958	62.18	5.487	11.33	.1269^{-1}	.1444^{-1}
7.32	.1816^{-3}	.2128^{-2}	.8535^{-1}	7.251	.6813^{-2}	127.2	2.342627	92.587	7.852	.3957	62.35	5.488	11.36	.1262^{-1}	.1440^{-1}
7.33	.1801^{-3}	.2115^{-2}	.8514^{-1}	7.261	.6772^{-2}	127.9	2.342900	92.635	7.841	.3957	62.52	5.489	11.39	.1254^{-1}	.1436^{-1}
7.34	.1785^{-3}	.2102^{-2}	.8492^{-1}	7.272	.6731^{-2}	128.7	2.343171	92.684	7.830	.3956	62.69	5.490	11.42	.1246^{-1}	.1432^{-1}
7.35	.1769^{-3}	.2089^{-2}	.8471^{-1}	7.282	.6691^{-2}	129.5	2.343442	92.732	7.820	.3956	62.86	5.492	11.45	.1239^{-1}	.1428^{-1}
7.36	.1754^{-3}	.2076^{-2}	.8450^{-1}	7.292	.6651^{-2}	130.3	2.343711	92.780	7.809	.3955	63.03	5.493	11.48	.1232^{-1}	.1424^{-1}
7.37	.1739^{-3}	.2063^{-2}	.8429^{-1}	7.302	.6612^{-2}	131.1	2.343980	92.828	7.798	.3955	63.20	5.494	11.50	.1224^{-1}	.1421^{-1}
7.38	.1724^{-3}	.2050^{-2}	.8408^{-1}	7.312	.6572^{-2}	131.9	2.344248	92.876	7.788	.3955	63.38	5.495	11.53	.1217^{-1}	.1417^{-1}
7.39	.1709^{-3}	.2037^{-2}	.8388^{-1}	7.322	.6533^{-2}	132.7	2.344514	92.923	7.777	.3954	63.55	5.497	11.56	.1210^{-1}	.1413^{-1}
7.40	.1694^{-3}	.2025^{-2}	.8367^{-1}	7.332	.6494^{-2}	133.5	2.344780	92.971	7.766	.3954	63.72	5.498	11.59	.1202^{-1}	.1409^{-1}
7.41	.1680^{-3}	.2012^{-2}	.8346^{-1}	7.342	.6456^{-2}	134.3	2.345044	93.018	7.756	.3953	63.89	5.499	11.62	.1195^{-1}	.1405^{-1}
7.42	.1665^{-3}	.2000^{-2}	.8326^{-1}	7.352	.6417^{-2}	135.2	2.345308	93.066	7.745	.3953	64.07	5.500	11.65	.1188^{-1}	.1402^{-1}
7.43	.1651^{-3}	.1988^{-2}	.8305^{-1}	7.362	.6379^{-2}	136.0	2.345571	93.112	7.735	.3952	64.24	5.502	11.68	.1181^{-1}	.1398^{-1}
7.44	.1637^{-3}	.1975^{-2}	.8285^{-1}	7.372	.6341^{-2}	136.8	2.345832	93.160	7.724	.3952	64.41	5.503	11.71	.1174^{-1}	.1394^{-1}
7.45	.1623^{-3}	.1963^{-2}	.8264^{-1}	7.383	.6304^{-2}	137.6	2.346093	93.207	7.714	.3951	64.59	5.504	11.73	.1167^{-1}	.1390
7.46	.1609^{-3}	.1951^{-2}	.8244^{-1}	7.393	.6267^{-2}	138.5	2.346353	93.254	7.704	.3951	64.76	5.505	11.76	.1160^{-1}	.1387
7.47	.1595^{-3}	.1939^{-2}	.8224^{-1}	7.403	.6229^{-2}	139.3	2.346612	93.300	7.693	.3950	64.93	5.507	11.79	.1153^{-1}	.1383
7.48	.1581^{-3}	.1927^{-2}	.8203^{-1}	7.413	.6193^{-2}	140.1	2.346870	93.347	7.683	.3950	65.11	5.508	11.82	.1146^{-1}	.1379^{-1}
7.49	.1568^{-3}	.1916^{-2}	.8183^{-1}	7.423	.6156^{-2}	141.0	2.347126	93.394	7.673	.3950	65.28	5.509	11.85	.1140^{-1}	.1376^{-1}
7.50	.1554^{-3}	.1904^{-2}	.8163^{-1}	7.433	.6120^{-2}	141.8	2.347382	93.440	7.662	.3949	65.46	5.510	11.88	.1133^{-1}	.1372^{-1}
7.51	.1541^{-3}	.1892^{-2}	.8143^{-1}	7.443	.6084^{-2}	142.7	2.347637	93.487	7.652	.3949	65.63	5.511	11.91	.1126^{-1}	.1368^{-1}
7.52	.1528^{-3}	.1881^{-2}	.8123^{-1}	7.453	.6048^{-2}	143.6	2.347892	93.533	7.642	.3948	65.81	5.513	11.94	.1120^{-1}	.1365^{-1}
7.53	.1515^{-3}	.1869^{-2}	.8104^{-1}	7.463	.6013^{-2}	144.4	2.348145	93.579	7.632	.3948	65.98	5.514	11.97	.1113^{-1}	.1361^{-1}
7.54	.1502^{-3}	.1858^{-2}	.8084^{-1}	7.473	.5977^{-2}	145.3	2.348397	93.624	7.621	.3947	66.16	5.515	12.00	.1106^{-1}	.1358^{-1}

TABLE II.—SUPERSONIC FLOW—Continued

$\gamma=7/5$

M or M_1	$\frac{p}{p_t}$	$\frac{\rho}{\rho_t}$	$\frac{T}{T_t}$	β	$\frac{q}{p_t}$	$\frac{A}{A_*}$	$\frac{V}{a_*}$	ν	μ	M_2	$\frac{p_2}{p_1}$	$\frac{\rho_2}{\rho_1}$	$\frac{T_2}{T_1}$	$\frac{p_{t_2}}{p_{t_1}}$	$\frac{p_1}{p_{t_2}}$
7.55	.1489 -3	.1847 -2	.8064 -1	7.483	.5942 -2	146.2	2.348648	93.670	7.611	.3947	66.34	5.516	12.03	.1100 -1	.1354 -1
7.56	.1477 -3	.1836 -2	.8045 -1	7.494	.5908 -2	147.0	2.348899	93.716	7.601	.3946	66.51	5.517	12.06	.1093 -1	.1351 -1
7.57	.1464 -3	.1824 -2	.8025 -1	7.504	.5873 -2	147.9	2.349148	93.762	7.591	.3946	66.69	5.518	12.09	.1087 -1	.1347 -1
7.58	.1452 -3	.1813 -2	.8006 -1	7.514	.5839 -2	148.8	2.349397	93.807	7.581	.3946	66.87	5.520	12.11	.1081 -1	.1343 -1
7.59	.1439 -3	.1802 -2	.7986 -1	7.524	.5805 -2	149.7	2.349644	93.853	7.571	.3945	67.04	5.521	12.14	.1074 -1	.1340 -1
7.60	.1427 -3	.1792 -2	.7967 -1	7.534	.5771 -2	150.6	2.349891	93.898	7.561	.3945	67.22	5.522	12.17	.1068 -1	.1336 -1
7.61	.1415 -3	.1781 -2	.7948 -1	7.544	.5737 -2	151.5	2.350137	93.943	7.551	.3944	67.40	5.523	12.20	.1062 -1	.1333 -1
7.62	.1403 -3	.1770 -2	.7928 -1	7.554	.5704 -2	152.4	2.350382	93.988	7.541	.3944	67.58	5.524	12.23	.1056 -1	.1329 -1
7.63	.1391 -3	.1759 -2	.7909 -1	7.564	.5671 -2	153.3	2.350626	94.033	7.531	.3943	67.75	5.525	12.26	.1049 -1	.1326 -1
7.64	.1380 -3	.1749 -2	.7890 -1	7.574	.5638 -2	154.2	2.350869	94.078	7.521	.3943	67.93	5.527	12.29	.1043 -1	.1322 -1
7.65	.1368 -3	.1738 -2	.7871 -1	7.584	.5605 -2	155.1	2.351112	94.123	7.511	.3943	68.11	5.528	12.32	.1037 -1	.1319 -1
7.66	.1357 -3	.1728 -2	.7852 -1	7.594	.5572 -2	156.0	2.351353	94.168	7.501	.3942	68.29	5.529	12.35	.1031 -1	.1316 -1
7.67	.1345 -3	.1717 -2	.7833 -1	7.605	.5540 -2	157.0	2.351594	94.212	7.491	.3942	68.47	5.530	12.38	.1025 -1	.1312 -1
7.68	.1334 -3	.1707 -2	.7815 -1	7.615	.5508 -2	157.9	2.351834	94.257	7.482	.3941	68.65	5.531	12.41	.1019 -1	.1309 -1
7.69	.1323 -3	.1697 -2	.7796 -1	7.625	.5476 -2	158.8	2.352072	94.301	7.472	.3941	68.83	5.532	12.44	.1013 -1	.1305 -1
7.70	.1312 -3	.1687 -2	.7777 -1	7.635	.5445 -2	159.8	2.352310	94.345	7.462	.3941	69.01	5.533	12.47	.1008 -1	.1302 -1
7.71	.1301 -3	.1677 -2	.7759 -1	7.645	.5413 -2	160.7	2.352548	94.389	7.452	.3940	69.18	5.534	12.50	.1002 -1	.1299 -1
7.72	.1290 -3	.1667 -2	.7740 -1	7.655	.5382 -2	161.7	2.352784	94.433	7.443	.3940	69.36	5.536	12.53	.9959 -2	.1295 -1
7.73	.1279 -3	.1657 -2	.7722 -1	7.665	.5351 -2	162.6	2.353019	94.477	7.433	.3939	69.55	5.537	12.56	.9902 -2	.1292 -1
7.74	.1269 -3	.1647 -2	.7703 -1	7.675	.5320 -2	163.6	2.353254	94.521	7.423	.3939	69.73	5.538	12.59	.9845 -2	.1289 -1
7.75	.1258 -3	.1637 -2	.7685 -1	7.685	.5290 -2	164.5	2.353488	94.565	7.414	.3939	69.91	5.539	12.62	.9788 -2	.1285 -1
7.76	.1248 -3	.1627 -2	.7667 -1	7.695	.5259 -2	165.5	2.353721	94.608	7.404	.3938	70.09	5.540	12.65	.9732 -2	.1282 -1
7.77	.1237 -3	.1618 -2	.7648 -1	7.705	.5229 -2	166.5	2.353953	94.652	7.395	.3938	70.27	5.541	12.68	.9676 -2	.1279 -1
7.78	.1227 -3	.1608 -2	.7630 -1	7.715	.5199 -2	167.4	2.354184	94.695	7.385	.3937	70.45	5.542	12.71	.9620 -2	.1276 -1
7.79	.1217 -3	.1599 -2	.7612 -1	7.726	.5170 -2	168.4	2.354415	94.739	7.375	.3937	70.63	5.543	12.74	.9565 -2	.1272 -1
7.80	.1207 -3	.1589 -2	.7594 -1	7.736	.5140 -2	169.4	2.354644	94.782	7.366	.3937	70.81	5.544	12.77	.9510 -2	.1269 -1
7.81	.1197 -3	.1580 -2	.7576 -1	7.746	.5111 -2	170.4	2.354873	94.825	7.356	.3936	71.00	5.545	12.80	.9456 -2	.1266 -1
7.82	.1187 -3	.1571 -2	.7558 -1	7.756	.5082 -2	171.4	2.355101	94.868	7.347	.3936	71.18	5.547	12.83	.9402 -2	.1263 -1
7.83	.1177 -3	.1561 -2	.7540 -1	7.766	.5053 -2	172.4	2.355328	94.911	7.338	.3935	71.36	5.548	12.86	.9348 -2	.1259 -1
7.84	.1168 -3	.1552 -2	.7523 -1	7.776	.5024 -2	173.4	2.355555	94.954	7.328	.3935	71.54	5.549	12.89	.9295 -2	.1256 -1
7.85	.1158 -3	.1543 -2	.7505 -1	7.786	.4995 -2	174.4	2.355780	94.996	7.319	.3935	71.73	5.550	12.92	.9242 -2	.1253 -1
7.86	.1149 -3	.1534 -2	.7487 -1	7.796	.4967 -2	175.4	2.356005	95.039	7.309	.3934	71.91	5.551	12.96	.9189 -2	.1250 -1
7.87	.1139 -3	.1525 -2	.7470 -1	7.806	.4939 -2	176.4	2.356229	95.082	7.300	.3934	72.09	5.552	12.99	.9137 -2	.1247 -1
7.88	.1130 -3	.1516 -2	.7452 -1	7.816	.4911 -2	177.5	2.356453	95.124	7.291	.3933	72.28	5.553	13.02	.9085 -2	.1244 -1
7.89	.1121 -3	.1507 -2	.7435 -1	7.826	.4883 -2	178.5	2.356675	95.166	7.281	.3933	72.46	5.554	13.05	.9033 -2	.1241 -1
7.90	.1111 -3	.1498 -2	.7417 -1	7.836	.4855 -2	179.5	2.356897	95.208	7.272	.3933	72.65	5.555	13.08	.8982 -2	.1237 -1
7.91	.1102 -3	.1490 -2	.7400 -1	7.847	.4828 -2	180.5	2.357118	95.251	7.263	.3932	72.83	5.556	13.11	.8931 -2	.1234 -1
7.92	.1093 -3	.1481 -2	.7383 -1	7.857	.4801 -2	181.6	2.357338	95.293	7.254	.3932	73.01	5.557	13.14	.8880 -2	.1231 -1
7.93	.1084 -3	.1472 -2	.7365 -1	7.867	.4774 -2	182.6	2.357557	95.334	7.245	.3932	73.20	5.558	13.17	.8830 -2	.1228 -1
7.94	.1076 -3	.1464 -2	.7348 -1	7.877	.4747 -2	183.7	2.357776	95.376	7.235	.3931	73.38	5.559	13.20	.8780 -2	.1225 -1
7.95	.1067 -3	.1455 -2	.7331 -1	7.887	.4720 -2	184.7	2.357994	95.418	7.226	.3931	73.57	5.560	13.23	.8731 -2	.1222 -1
7.96	.1058 -3	.1447 -2	.7314 -1	7.897	.4693 -2	185.8	2.358211	95.460	7.217	.3930	73.76	5.561	13.26	.8682 -2	.1219 -1
7.97	.1050 -3	.1438 -2	.7297 -1	7.907	.4667 -2	186.9	2.358427	95.501	7.208	.3930	73.94	5.562	13.29	.8633 -2	.1216 -1
7.98	.1041 -3	.1430 -2	.7280 -1	7.917	.4641 -2	188.0	2.358642	95.542	7.199	.3930	74.13	5.563	13.33	.8584 -2	.1213 -1
7.99	.1033 -3	.1422 -2	.7263 -1	7.927	.4615 -2	189.0	2.358857	95.584	7.190	.3929	74.31	5.564	13.36	.8536 -2	.1210 -1
8.00	.1024 -3	.1414 -2	.7246 -1	7.937	.4589 -2	190.1	2.359071	95.625	7.181	.3929	74.50	5.565	13.39	.8488 -2	.1207 -1
8.01	.1016 -3	.1405 -2	.7230 -1	7.947	.4563 -2	191.2	2.359285	95.666	7.172	.3929	74.69	5.566	13.42	.8440 -2	.1204 -1
8.02	.1008 -3	.1397 -2	.7213 -1	7.957	.4538 -2	192.3	2.359497	95.707	7.163	.3928	74.87	5.567	13.45	.8393 -2	.1201 -1
8.03	.9997 -4	.1389 -2	.7196 -1	7.967	.4512 -2	193.4	2.359709	95.748	7.154	.3928	75.06	5.568	13.48	.8346 -2	.1198 -1
8.04	.9916 -4	.1381 -2	.7180 -1	7.978	.4487 -2	194.5	2.359920	95.789	7.145	.3927	75.25	5.569	13.51	.8299 -2	.1195 -1
8.05	.9837 -4	.1373 -2	.7163 -1	7.988	.4462 -2	195.6	2.360130	95.830	7.136	.3927	75.44	5.570	13.54	.8253 -2	.1192 -1
8.06	.9758 -4	.1365 -2	.7147 -1	7.998	.4437 -2	196.7	2.360340	95.871	7.127	.3927	75.62	5.571	13.57	.8207 -2	.1189 -1
8.07	.9679 -4	.1358 -2	.7130 -1	8.008	.4413 -2	197.8	2.360549	95.911	7.118	.3926	75.81	5.572	13.61	.8161 -2	.1186 -1
8.08	.9602 -4	.1350 -2	.7114 -1	8.018	.4388 -2	199.0	2.360757	95.951	7.109	.3926	76.00	5.573	13.64	.8115 -2	.1183 -1
8.09	.9525 -4	.1342 -2	.7097 -1	8.028	.4364 -2	200.1	2.360965	95.992	7.100	.3926	76.19	5.574	13.67	.8070 -2	.1180 -1
8.10	.9449 -4	.1334 -2	.7081 -1	8.038	.4339 -2	201.2	2.361172	96.032	7.092	.3925	76.38	5.575	13.70	.8025 -2	.1177 -1
8.11	.9373 -4	.1327 -2	.7065 -1	8.048	.4315 -2	202.4	2.361378	96.073	7.083	.3925	76.57	5.576	13.73	.7981 -2	.1174 -1
8.12	.9298 -4	.1319 -2	.7049 -1	8.058	.4292 -2	203.5	2.361583	96.112	7.074	.3925	76.76	5.577	13.76	.7937 -2	.1172 -1
8.13	.9224 -4	.1312 -2	.7033 -1	8.068	.4268 -2	204.6	2.361788	96.153	7.065	.3924	76.95	5.578	13.80	.7893 -2	.1169 -1
8.14	.9150 -4	.1304 -2	.7017 -1	8.078	.4244 -2	205.8	2.361992	96.193	7.057	.3924	77.14	5.579	13.83	.7849 -2	.1166 -1
8.15	.9078 -4	.1297 -2	.7001 -1	8.088	.4221 -2	207.0	2.362195	96.233	7.048	.3924	77.33	5.580	13.86	.7805 -2	.1163 -1
8.16	.9005 -4	.1289 -2	.6985 -1	8.098	.4197 -2	208.1	2.362397	96.272	7.039	.3923	77.52	5.581	13.89	.7762 -2	.1160 -1
8.17	.8934 -4	.1282 -2	.6969 -1	8.109	.4174 -2	209.3	2.362599	96.312	7.031	.3923	77.71	5.582	13.92	.7719 -2	.1157 -1
8.18	.8863 -4	.1275 -2	.6953 -1	8.119	.4151 -2	210.5	2.362800	96.352	7.022	.3923	77.90	5.583	13.95	.7677 -2	.1155 -1
8.19	.8793 -4	.1267 -2	.6937 -1	8.129	.4129 -2	211.7	2.363001	96.391	7.013	.3922	78.09	5.584	13.99	.7634 -2	.1152 -1
8.20	.8723 -4	.1260 -2	.6921 -1	8.139	.4106 -2	212.8	2.363201	96.430	7.005	.3922	78.28	5.585	14.02	.7592 -2	.1149 -1
8.21	.8654 -4	.1253 -2	.6906 -1	8.149	.4083 -2	214.0	2.363400	96.470	6.996	.3921	78.47	5.586	14.05	.7551 -2	.1146 -1
8.22	.8586 -4	.1246 -2	.6890 -1	8.159	.4061 -2	215.2	2.363598	96.509	6.988	.3921	78.66	5.587	14.08	.7509 -2	.1143 -1
8.23	.8518 -4	.1239 -2	.6874 -1	8.169	.4039 -2	216.4	2.363796	96.548	6.979	.3921	78.86	5.588	14.11	.7468 -2	.1141 -1
8.24	.8451 -4	.1232 -2	.6859 -1	8.179	.4017 -2	217.7	2.363993	96.587	6.971	.3920	79.05	5.588	14.15	.7427 -2	.1138 -1
8.25	.8384 -4	.1225 -2	.6843 -1	8.189	.3995 -2	218.9	2.364190	96.626	6.962	.3920	79.24	5.589	14.18	.7386 -2	.1135 -1
8.26	.8318 -4	.1218 -2	.6828 -1	8.199	.3973 -2	220.1	2.364385	96.665	6.954	.3920	79.43	5.590	14.21	.7346 -2	.1132 -1
8.27	.8253 -4	.1211 -2	.6813 -1	8.209	.3951 -2	221.3	2.364581	96.704	6.945	.3919	79.63	5.591	14.24	.7306 -2	.1130 -1
8.28	.8188 -4	.1205 -2	.6797 -1	8.219	.3930 -2	222.5	2.364775	96.742	6.937	.3919	79.82	5.592	14.27	.7266 -2	.1127 -1
8.29	.8124 -4	.1198 -2	.6782 -1	8.229	.3908 -2	223.8	2.364969	96.781	6.928	.3919	80.01	5.593	14.31	.7226 -2	.1124 -1
8.30	.8060 -4	.1191 -2	.6767 -1	8.240	.3887 -2	225.0	2.365162	96.820	6.920	.3918	80.21	5.594	14.34	.7187 -2	.1122 -1
8.31	.7997 -4	.1184 -2	.6752 -1	8.250	.3866 -2	226.3	2.365354	96.858	6.912	.3918	80.40	5.595	14.37	.7147 -2	.1119 -1
8.32	.7935 -4	.1178 -2	.6737 -1	8.260	.3845 -2	227.5	2.365546	96.896	6.903	.3918	80.59	5.596	14.40	.7109 -2	.1116 -1
8.33	.7873 -4	.1171 -2	.6721 -1	8.270	.3824 -2	228.8	2.365738	96.935	6.895	.3917	80.79	5.597	14.44	.7070 -2	.1114 -1
8.34	.7811 -4	.1165 -2	.6706 -1	8.280	.3803 -2	230.0	2.365928	96.973	6.887	.3917	80.98	5.598	14.47	.7031 -2	.1111 -1
8.35	.7750 -4	.1158 -2	.6691 -1	8.290	.3783 -2	231.3	2.366118	97.011	6.878	.3917	81.18	5.599	14.50	.6993 -2	.1108 -1
8.36	.7690 -4	.1152 -2	.6676 -1	8.300	.3762 -2	232.6	2.366307	97.049	6.870	.3917	81.37	5.599	14.53	.6955 -2	.1106 -1
8.37	.7630 -4	.1145 -2	.6662 -1	8.310	.3742 -2	233.9	2.366496	97.087	6.862	.3916	81.57	5.600	14.57	.6918 -2	.1103 -1
8.38	.7571 -4	.1139 -2	.6647 -1	8.320	.3722 -2	235.2	2.366684	97.125	6.854	.3916	81.76	5.601	14.60	.6880 -2	.1100 -1
8.39	.7512 -4	.1133 -2	.6632 -1	8.330	.3702 -2	236.5	2.366871	97.162	6.845	.3916	81.96	5.602	14.63	.6843 -2	.1098 -1
8.40	.7454 -4	.1126 -2	.6617 -1	8.340	.3682 -2	237.8	2.367058	97.200	6.837	.3915	82.15	5.603	14.66	.6806 -2	.1095 -1
8.41	.7396 -4	.1120 -2	.6603 -1	8.350	.3662 -2	239.1	2.367244	97.238	6.829	.3915	82.35	5.604	14.70	.6769 -2	.1093 -1
8.42	.7339 -4	.1114 -2	.6588 -1	8.360	.3642 -2	240.4	2.367430	97.276	6.821	.3915	82.55	5.605	14.73	.6733 -2	.1090 -1
8.43	.7282 -4	.1108 -2	.6573 -1	8.370	.3623 -2	241.7	2.367615	97.313	6.813	.3914	82.74	5.606	14.76	.6697 -2	.1087 -1
8.44	.7226 -4	.1102 -2	.6559 -1	8.381	.3603 -2	243.0	2.367799	97.350	6.805	.3914	82.94	5.606	14.79	.6661 -2	.1085 -1

TABLE II.—SUPERSONIC FLOW—Continued

$\gamma=7/5$

M or M_1	$\frac{p}{p_t}$	$\frac{\rho}{\rho_t}$	$\frac{T}{T_t}$	β	$\frac{q}{p_t}$	$\frac{A}{A_*}$	$\frac{V}{a_*}$	ν	μ	M_2	$\frac{p_2}{p_1}$	$\frac{\rho_2}{\rho_1}$	$\frac{T_2}{T_1}$	$\frac{p_{t_2}}{p_{t_1}}$	$\frac{p_1}{p_{t_2}}$
8.45	.7170 -4	.1096 -2	.6544 -1	8.391	.3584 -2	244.4	2.367983	97.388	6.797	.3914	83.14	5.607	14.83	.6625 -2	.1082 -1
8.46	.7115 -4	.1090 -2	.6530 -1	8.401	.3565 -2	245.7	2.368166	97.424	6.788	.3913	83.33	5.608	14.86	.6589 -2	.1080 -1
8.47	.7060 -4	.1084 -2	.6515 -1	8.411	.3545 -2	247.0	2.368348	97.462	6.780	.3913	83.53	5.609	14.89	.6554 -2	.1077 -1
8.48	.7006 -4	.1078 -2	.6501 -1	8.421	.3526 -2	248.4	2.368530	97.499	6.772	.3913	83.73	5.610	14.93	.6519 -2	.1075 -1
8.49	.6952 -4	.1072 -2	.6487 -1	8.431	.3508 -2	249.7	2.368712	97.536	6.764	.3912	83.93	5.611	14.96	.6484 -2	.1072 -1
8.50	.6898 -4	.1066 -2	.6472 -1	8.441	.3489 -2	251.1	2.368892	97.573	6.756	.3912	84.13	5.612	14.99	.6449 -2	.1970 -1
8.51	.6846 -4	.1060 -2	.6458 -1	8.451	.3470 -2	252.5	2.369072	97.609	6.748	.3912	84.32	5.613	15.02	.6415 -2	.1067 -1
8.52	.6793 -4	.1054 -2	.6444 -1	8.461	.3452 -2	253.8	2.369252	97.646	6.740	.3911	84.52	5.613	15.06	.6380 -2	.1065 -1
8.53	.6741 -4	.1048 -2	.6430 -1	8.471	.3433 -2	255.2	2.369431	97.683	6.732	.3911	84.72	5.614	15.09	.6346 -2	.1062 -1
8.54	.6690 -4	.1043 -2	.6416 -1	8.481	.3415 -2	256.6	2.369609	97.719	6.725	.3911	84.92	5.615	15.12	.6313 -2	.1060 -1
8.55	.6638 -4	.1037 -2	.6402 -1	8.491	.3397 -2	258.0	2.369787	97.756	6.717	.3911	85.12	5.616	15.16	.6279 -2	.1057 -1
8.56	.6588 -4	.1031 -2	.6388 -1	8.501	.3379 -2	259.4	2.369964	97.792	6.709	.3910	85.32	5.617	15.19	.6246 -2	.1055 -1
8.57	.6538 -4	.1026 -2	.6374 -1	8.511	.3361 -2	260.8	2.370140	97.828	6.701	.3910	85.52	5.618	15.22	.6212 -2	.1052 -1
8.58	.6488 -4	.1020 -2	.6360 -1	8.522	.3343 -2	262.2	2.370316	97.865	6.693	.3910	85.72	5.618	15.26	.6179 -2	.1050 -1
8.59	.6438 -4	.1015 -2	.6346 -1	8.532	.3326 -2	263.6	2.370492	97.901	6.685	.3909	85.92	5.619	15.29	.6147 -2	.1048 -1
8.60	.6390 -4	.1009 -2	.6332 -1	8.542	.3308 -2	265.0	2.370667	97.937	6.677	.3909	86.12	5.620	15.32	.6114 -2	.1045 -1
8.61	.6341 -4	.1004 -2	.6319 -1	8.552	.3291 -2	266.4	2.370841	97.973	6.670	.2909	86.32	5.621	15.36	.6082 -2	.1043 -1
8.62	.6293 -4	.9981 -3	.6305 -1	8.562	.3273 -2	267.9	2.371015	98.009	6.662	.3909	86.52	5.622	15.39	.6050 -2	.1040 -1
8.63	.6245 -4	.9927 -3	.6291 -1	8.572	.3256 -2	269.3	2.371188	98.045	6.654	.3908	86.72	5.623	15.42	.6018 -2	.1038 -1
8.64	.6198 -4	.9873 -3	.6277 -1	8.582	.3239 -2	270.8	2.371360	98.081	6.646	.3908	86.92	5.623	15.46	.5986 -2	.1035 -1
8.65	.6151 -4	.9820 -3	.6264 -1	8.592	.3222 -2	272.2	2.371532	98.116	6.639	.3908	87.13	5.624	15.49	.5954 -2	.1033 -1
8.66	.6105 -4	.9767 -3	.6250 -1	8.602	.3205 -2	273.7	2.371704	98.152	6.631	.3907	87.33	5.625	15.53	.5923 -2	.1031 -1
8.67	.6059 -4	.9714 -3	.6237 -1	8.612	.3188 -2	275.1	2.371875	98.187	6.623	.3907	87.53	5.626	15.56	.5892 -2	.1028 -1
8.68	.6013 -4	.9662 -3	.6223 -1	8.622	.3171 -2	276.6	2.372045	98.223	6.616	.3907	87.73	5.627	15.59	.5861 -2	.1026 -1
8.69	.5968 -4	.9610 -3	.6210 -1	8.632	.3155 -2	278.1	2.372215	98.258	6.608	.3906	87.94	5.627	15.63	.5830 -2	.1024 -1
8.70	.5923 -4	.9558 -3	.6197 -1	8.642	.3138 -2	279.6	2.372384	98.293	6.600	.3906	88.14	5.628	15.66	.5799 -2	.1021 -1
8.71	.5878 -4	.9507 -3	.6183 -1	8.652	.3122 -2	281.1	2.372553	98.329	6.593	.3906	88.34	5.629	15.69	.5769 -2	.1019 -1
8.72	.5834 -4	.9456 -3	.6170 -1	8.662	.3105 -2	282.6	2.372721	98.364	6.585	.3906	88.54	5.630	15.73	.5739 -2	.1017 -1
8.73	.5790 -4	.9405 -3	.6157 -1	8.673	.3089 -2	284.1	2.372889	98.399	6.578	.3905	88.75	5.631	15.76	.5709 -2	.1014 -1
8.74	.5747 -4	.9355 -3	.6143 -1	8.683	.3073 -2	285.6	2.373056	98.434	6.570	.3905	88.95	5.631	15.80	.5679 -2	.1012 -1
8.75	.5704 -4	.9305 -3	.6130 -1	8.693	.3057 -2	287.1	2.373222	98.469	6.562	.3905	89.16	5.632	15.83	.5649 -2	.1010 -1
8.76	.5661 -4	.9255 -3	.6117 -1	8.703	.3041 -2	288.6	2.373388	98.504	6.555	.3904	89.36	5.633	15.86	.5620 -2	.1007 -1
8.77	.5619 -4	.9205 -3	.6104 -1	8.713	.3025 -2	290.1	2.373554	98.539	6.547	.3904	89.57	5.634	15.90	.5590 -2	.1005 -1
8.78	.5577 -4	.9156 -3	.6091 -1	8.723	.3010 -2	291.7	2.373719	98.573	6.540	.3904	89.77	5.635	15.93	.5561 -2	.1003 -1
8.79	.5536 -4	.9108 -3	.6078 -1	8.733	.2994 -2	293.2	2.373883	98.608	6.532	.3904	89.97	5.635	15.97	.5532 -2	.1001 -1
8.80	.5494 -4	.9059 -3	.6065 -1	8.743	.2978 -2	294.8	2.374047	98.642	6.525	.3903	90.18	5.636	16.00	.5504 -2	.9983 -2
8.81	.5453 -4	.9011 -3	.6052 -1	8.753	.2963 -2	296.3	2.374210	98.677	6.518	.3903	90.39	5.637	16.04	.5475 -2	.9960 -2
8.82	.5413 -4	.8963 -3	.6039 -1	8.763	.2948 -2	297.9	2.374373	98.711	6.510	.3903	90.59	5.638	16.07	.5447 -2	.9938 -2
8.83	.5373 -4	.8915 -3	.6026 -1	8.773	.2932 -2	299.5	2.374535	98.745	6.503	.3903	90.80	5.638	16.10	.5418 -2	.9916
8.84	.5333 -4	.8868 -3	.6014 -1	8.783	.2917 -2	301.0	2.374697	98.780	6.495	.3902	91.00	5.639	16.14	.5390 -2	.9893
8.85	.5293 -4	.8821 -3	.6001 -1	8.793	.2902 -2	302.6	2.374859	98.814	6.488	.3902	91.21	5.640	16.17	.5362 -2	.9871
8.86	.5254 -4	.8774 -3	.5988 -1	8.803	.2887 -2	304.2	2.375019	98.848	6.481	.3902	91.42	5.641	16.21	.5335 -2	.9849
8.87	.5215 -4	.8728 -3	.5975 -1	8.813	.2872 -2	305.8	2.375180	98.882	6.473	.3901	91.62	5.641	16.24	.5307 -2	.9827 -2
8.88	.5177 -4	.8682 -3	.5963 -1	8.824	.2857 -2	307.4	2.375339	98.916	6.466	.3901	91.83	5.642	16.28	.5280 -2	.9805 -2
8.89	.5139 -4	.8636 -3	.5950 -1	8.834	.2843 -2	309.0	2.375499	98.950	6.459	.3901	92.04	5.643	16.31	.5253 -2	.9783 -2
8.90	.5101 -4	.8590 -3	.5938 -1	8.844	.2828 -2	310.6	2.375657	98.984	6.451	.3901	92.25	5.644	16.35	.5226 -2	.9761 -2
8.91	.5063 -4	.8545 -3	.5925 -1	8.854	.2814 -2	312.3	2.375816	99.018	6.444	.3900	92.45	5.645	16.38	.5199 -2	.9739 -2
8.92	.5026 -4	.8500 -3	.5913 -1	8.864	.2799 -2	313.9	2.375973	99.051	6.437	.3900	92.66	5.645	16.41	.5172 -2	.9718 -2
8.93	.4989 -4	.8456 -3	.5900 -1	8.874	.2785 -2	315.5	2.376131	99.085	6.430	.3900	92.87	5.646	16.45	.5145 -2	.9696 -2
8.94	.4952 -4	.8411 -3	.5888 -1	8.884	.2771 -2	317.2	2.376287	99.119	6.422	.3900	93.08	5.647	16.48	.5119 -2	.9675 -2
8.95	.4916 -4	.8367 -3	.5875 -1	8.894	.2756 -2	318.8	2.376444	99.152	6.415	.3899	93.29	5.647	16.52	.5093 -2	.9653 -2
8.96	.4880 -4	.8323 -3	.5863 -1	8.904	.2742 -2	320.5	2.376599	99.186	6.408	.3899	93.50	5.648	16.55	.5067 -2	.9631 -2
8.97	.4844 -4	.8280 -3	.5851 -1	8.914	.2728 -2	322.1	2.376755	99.219	6.401	.3899	93.70	5.649	16.59	.5041 -2	.9610 -2
8.98	.4809 -4	.8236 -3	.5838 -1	8.924	.2714 -2	323.8	2.376909	99.252	6.394	.3899	93.91	5.650	16.62	.5015 -2	.9589 -2
8.99	.4773 -4	.8193 -3	.5826 -1	8.934	.2701 -2	325.5	2.377064	99.286	6.387	.3898	94.12	5.650	16.66	.4989 -2	.9567 -2
9.00	.4739 -4	.8150 -3	.5814 -1	8.944	.2687 -2	327.2	2.377217	99.319	6.379	.3898	94.33	5.651	16.69	.4964 -2	.9546 -2
9.01	.4704 -4	.8108 -3	.5802 -1	8.954	.2673 -2	328.9	2.377371	99.352	6.372	.3898	94.54	5.652	16.73	.4939 -2	.9525 -2
9.02	.4670 -4	.8066 -3	.5790 -1	8.964	.2660 -2	330.6	2.377524	99.384	6.365	.3897	94.75	5.653	16.76	.4913 -2	.9504 -2
9.03	.4636 -4	.8024 -3	.5778 -1	8.974	.2646 -2	332.3	2.377676	99.417	6.358	.3897	94.96	5.653	16.80	.4888 -2	.9483 -2
9.04	.4602 -4	.7982 -3	.5766 -1	8.985	.2633 -2	334.0	2.377828	99.451	6.351	.3897	95.18	5.654	16.83	.4864 -2	.9462 -2
9.05	.4569 -4	.7940 -3	.5754 -1	8.995	.2619 -2	335.7	2.377979	99.483	6.344	.3897	95.39	5.655	16.87	.4839 -2	.9441 -2
9.06	.4535 -4	.7899 -3	.5742 -1	9.005	.2606 -2	337.5	2.378130	99.516	6.337	.3896	95.60	5.656	16.90	.4814 -2	.9421 -2
9.07	.4503 -4	.7858 -3	.5730 -1	9.015	.2593 -2	339.2	2.378281	99.549	6.330	.3896	95.81	5.656	16.94	.4790 -2	.9400 -2
9.08	.4470 -4	.7818 -3	.5718 -1	9.025	.2580 -2	340.9	2.378431	99.581	6.323	.3896	96.02	5.657	16.97	.4766 -2	.9380 -2
9.09	.4438 -4	.7777 -3	.5706 -1	9.035	.2567 -2	342.7	2.378580	99.614	6.316	.3896	96.23	5.658	17.01	.4742 -2	.9359 -2
9.10	.4405 -4	.7737 -3	.5694 -1	9.045	.2554 -2	344.5	2.378729	99.646	6.309	.3895	96.45	5.658	17.05	.4718 -2	.9338 -2
9.11	.4374 -4	.7697 -3	.5682 -1	9.055	.2541 -2	346.2	2.378878	99.679	6.302	.3895	96.66	5.659	17.08	.4694 -2	.9318 -2
9.12	.4342 -4	.7657 -3	.5671 -1	9.065	.2528 -2	348.0	2.379026	99.711	6.295	.3895	96.87	5.660	17.12	.4670 -2	.9298 -2
9.13	.4311 -4	.7618 -3	.5659 -1	9.075	.2515 -2	349.8	2.379174	99.743	6.288	.3895	97.08	5.660	17.15	.4646 -2	.9277 -2
9.14	.4280 -4	.7578 -3	.5647 -1	9.085	.2503 -2	351.6	2.379321	99.775	6.281	.3894	97.30	5.661	17.19	.4623 -2	.9257 -2
9.15	.4249 -4	.7539 -3	.5636 -1	9.095	.2490 -2	353.4	2.379468	99.807	6.274	.3894	97.51	5.662	17.22	.4600 -2	.9237 -2
9.16	.4218 -4	.7501 -3	.5624 -1	9.105	.2478 -2	355.2	2.379614	99.840	6.268	.3894	97.72	5.663	17.26	.4577 -2	.9217 -2
9.17	.4188 -4	.7462 -3	.5612 -1	9.115	.2465 -2	357.0	2.379760	99.872	6.261	.3894	97.94	5.663	17.29	.4554 -2	.9197 -2
9.18	.4158 -4	.7424 -3	.5601 -1	9.125	.2453 -2	358.8	2.379905	99.904	6.254	.3893	98.15	5.664	17.33	.4531 -2	.9177 -2
9.19	.4128 -4	.7386 -3	.5589 -1	9.135	.2441 -2	360.6	2.380050	99.936	6.247	.3893	98.37	5.665	17.37	.4508 -2	.9158 -2
9.20	.4099 -4	.7348 -3	.5578 -1	9.145	.2428 -2	362.5	2.380195	99.967	6.240	.3893	98.58	5.665	17.40	.4486 -2	.9138 -2
9.21	.4069 -4	.7310 -3	.5566 -1	9.156	.2416 -2	364.3	2.380339	99.999	6.233	.3893	98.79	5.666	17.44	.4463 -2	.9118 -2
9.22	.4040 -4	.7273 -3	.5555 -1	9.166	.2404 -2	366.2	2.380483	100.031	6.227	.3892	99.01	5.667	17.47	.4441 -2	.9098 -2
9.23	.4011 -4	.7236 -3	.5544 -1	9.176	.2392 -2	368.0	2.380626	100.062	6.220	.3892	99.23	5.667	17.51	.4419 -2	.9078 -2
9.24	.3983 -4	.7199 -3	.5532 -1	9.186	.2380 -2	369.9	2.380769	100.094	6.213	.3892	99.44	5.668	17.54	.4397 -2	.9059 -2
9.25	.3954 -4	.7162 -3	.5521 -1	9.196	.2368 -2	371.7	2.380911	100.125	6.206	.3892	99.66	5.669	17.58	.4375 -2	.9040
9.26	.3926 -4	.7126 -3	.5510 -1	9.206	.2357 -2	373.6	2.381053	100.157	6.200	.3892	99.87	5.669	17.62	.4353 -2	.902[illegible]
9.27	.3898 -4	.7090 -3	.5499 -1	9.216	.2345 -2	375.5	2.381194	100.188	6.193	.3891	100.1	5.670	17.65	.4331 -2	.9000
9.28	.3871 -4	.7054 -3	.5487 -1	9.226	.2333 -2	377.4	2.381335	100.219	6.186	.3891	100.3	5.671	17.69	.4310 -2	.8981
9.29	.3843 -4	.7018 -3	.5476 -1	9.236	.2322 -2	379.3	2.381476	100.251	6.179	.3891	100.5	5.671	17.72	.4288 -2	.8962
9.30	.3816 -4	.6982 -3	.5465 -1	9.246	.2310 -2	381.2	2.381616	100.282	6.173	.3891	100.7	5.672	17.76	.4267 -2	.8943 -2
9.31	.3789 -4	.6947 -3	.5454 -1	9.256	.2299 -2	383.1	2.381756	100.313	6.166	.3890	101.0	5.673	17.80	.4246 -2	.8924 -2
9.32	.3762 -4	.6912 -3	.5443 -1	9.266	.2287 -2	385.1	2.381895	100.344	6.160	.3890	101.2	5.673	17.83	.4225 -2	.8904 -2
9.33	.3735 -4	.6877 -3	.5432 -1	9.276	.2276 -2	387.0	2.382034	100.375	6.153	.3890	101.4	5.674	17.87	.4204 -2	.8885 -2
9.34	.3709 -4	.6842 -3	.5421 -1	9.286	.2265 -2	389.0	2.382173	100.406	6.146	.3890	101.6	5.675	17.91	.4183 -2	.8867 -2

TABLE II.—SUPERSONIC FLOW—Continued

$\gamma=7/5$

M or M_1	$\frac{p}{p_t}$	$\frac{\rho}{\rho_t}$	$\frac{T}{T_t}$	β	$\frac{q}{p_t}$	$\frac{A}{A_*}$	$\frac{V}{a_*}$	ν	μ	M_2	$\frac{p_2}{p_1}$	$\frac{\rho_2}{\rho_1}$	$\frac{T_2}{T_1}$	$\frac{p_{t_2}}{p_{t_1}}$	$\frac{p_1}{p_{t_2}}$
9.35	.3683^{-4}	.6807^{-3}	.5410^{-1}	9.296	.2254^{-2}	390.9	2.382311	100.436	6.140	.3889	101.8	5.675	17.94	.4102^{-2}	.8849^{-2}
9.36	.3657^{-4}	.6773^{-3}	.5399^{-1}	9.306	.2243^{-2}	392.9	2.382448	100.467	6.133	.3889	102.0	5.676	17.98	.4112^{-2}	.8828^{-2}
9.37	.3631^{-4}	.6739^{-3}	.5388^{-1}	9.316	.2232^{-2}	394.8	2.382585	100.498	6.127	.3889	102.3	5.677	18.01	.4121^{-2}	.8809^{-2}
9.38	.3605^{-4}	.6705^{-3}	.5377^{-1}	9.327	.2221^{-2}	396.8	2.382722	100.529	6.120	.3889	102.5	5.677	18.05	.4101^{-2}	.8791^{-2}
9.39	.3580^{-4}	.6671^{-3}	.5366^{-1}	9.337	.2210^{-2}	398.8	2.382859	100.559	6.113	.3888	102.7	5.678	18.09	.4081^{-2}	.8773^{-2}
9.40	.3555^{-4}	.6638^{-3}	.5356^{-1}	9.347	.2199^{-2}	400.8	2.382995	100.590	6.107	.3888	102.9	5.679	18.12	.4061^{-2}	.8754^{-2}
9.41	.3530^{-4}	.6604^{-3}	.5345^{-1}	9.357	.2188^{-2}	402.8	2.383130	100.620	6.100	.3888	103.1	5.679	18.16	.4041^{-2}	.8736^{-2}
9.42	.3505^{-4}	.6571^{-3}	.5334^{-1}	9.367	.2177^{-2}	404.8	2.383265	100.651	6.094	.3888	103.4	5.680	18.20	.4021^{-2}	.8718^{-2}
9.43	.3481^{-4}	.6538^{-3}	.5323^{-1}	9.377	.2167^{-2}	406.8	2.383400	100.681	6.087	.3888	103.6	5.681	18.23	.4001^{-2}	.8699^{-2}
9.44	.3456^{-4}	.6506^{-3}	.5313^{-1}	9.387	.2156^{-2}	408.8	2.383534	100.711	6.081	.3887	103.8	5.681	18.27	.3982^{-2}	.8681^{-2}
9.45	.3432^{-4}	.6473^{-3}	.5302^{-1}	9.397	.2146^{-2}	410.9	2.383668	100.742	6.074	.3887	104.0	5.682	18.31	.3962^{-2}	.8662^{-2}
9.46	.3408^{-4}	.6441^{-3}	.5291^{-1}	9.407	.2135^{-2}	412.9	2.383802	100.772	6.068	.3887	104.2	5.683	18.34	.3943^{-2}	.8644^{-2}
9.47	.3384^{-4}	.6409^{-3}	.5281^{-1}	9.417	.2125^{-2}	414.9	2.383935	100.802	6.062	.3887	104.5	5.683	18.38	.3924^{-2}	.8626^{-2}
9.48	.3361^{-4}	.6377^{-3}	.5270^{-1}	9.427	.2114^{-2}	417.0	2.384068	100.832	6.055	.3886	104.7	5.684	18.42	.3904^{-2}	.8607^{-2}
9.49	.3337^{-4}	.6345^{-3}	.5260^{-1}	9.437	.2104^{-2}	419.1	2.384200	100.862	6.049	.3886	104.9	5.684	18.45	.3885^{-2}	.8589^{-2}
9.50	.3314^{-4}	.6313^{-3}	.5249^{-1}	9.447	.2094^{-2}	421.1	2.384332	100.892	6.042	.3886	105.1	5.685	18.49	.3866^{-2}	.8572^{-2}
9.51	.3291^{-4}	.6282^{-3}	.5239^{-1}	9.457	.2084^{-2}	423.2	2.384464	100.922	6.036	.3886	105.3	5.686	18.53	.3848^{-2}	.8554^{-2}
9.52	.3268^{-4}	.6251^{-3}	.5228^{-1}	9.467	.2073^{-2}	425.3	2.384595	100.952	6.030	.3886	105.6	5.686	18.57	.3829^{-2}	.8536^{-2}
9.53	.3246^{-4}	.6220^{-3}	.5218^{-1}	9.477	.2063^{-2}	427.4	2.384726	100.981	6.023	.3885	105.8	5.687	18.60	.3810^{-2}	.8518^{-2}
9.54	.3223^{-4}	.6189^{-3}	.5208^{-1}	9.487	.2053^{-2}	429.5	2.384856	101.011	6.017	.3885	106.0	5.688	18.64	.3792^{-2}	.8500^{-2}
9.55	.3201^{-4}	.6158^{-3}	.5197^{-1}	9.498	.2043^{-2}	431.6	2.384986	101.041	6.011	.3885	106.2	5.688	18.68	.3773^{-2}	.8483^{-2}
9.56	.3179^{-4}	.6128^{-3}	.5187^{-1}	9.508	.2034^{-2}	433.7	2.385116	101.070	6.004	.3885	106.5	5.689	18.71	.3755^{-2}	.8465^{-2}
9.57	.3157^{-4}	.6098^{-3}	.5177^{-1}	9.518	.2024^{-2}	435.9	2.385245	101.100	5.998	.3884	106.7	5.689	18.75	.3737^{-2}	.8447^{-2}
9.58	.3135^{-4}	.6067^{-3}	.5167^{-1}	9.528	.2014^{-2}	438.0	2.385374	101.129	5.992	.3884	106.9	5.690	18.79	.3719^{-2}	.8431^{-2}
9.59	.3113^{-4}	.6037^{-3}	.5156^{-1}	9.538	.2004^{-2}	440.2	2.385502	101.159	5.985	.3884	107.1	5.691	18.83	.3701^{-2}	.8412^{-2}
9.60	.3092^{-4}	.6008^{-3}	.5146^{-1}	9.548	.1995^{-2}	442.3	2.385630	101.188	5.979	.3884	107.4	5.691	18.86	.3683^{-2}	.8394^{-2}
9.61	.3070^{-4}	.5978^{-3}	.5136^{-1}	9.558	.1985^{-2}	444.5	2.385758	101.217	5.973	.3884	107.6	5.692	18.90	.3665^{-2}	.8378^{-2}
9.62	.3049^{-4}	.5949^{-3}	.5126^{-1}	9.568	.1975^{-2}	446.7	2.385885	101.247	5.967	.3883	107.8	5.692	18.94	.3647^{-2}	.8360^{-2}
9.63	.3028^{-4}	.5919^{-3}	.5116^{-1}	9.578	.1966^{-2}	448.8	2.386012	101.276	5.960	.3883	108.0	5.693	18.98	.3630^{-2}	.8343^{-2}
9.64	.3007^{-4}	.5890^{-3}	.5106^{-1}	9.588	.1956^{-2}	451.0	2.386139	101.305	5.954	.3883	108.3	5.694	19.01	.3612^{-2}	.8325^{-2}
9.65	.2987^{-4}	.5861^{-3}	.5096^{-1}	9.598	.1947^{-2}	453.2	2.386265	101.334	5.948	.3883	108.5	5.694	19.05	.3595^{-2}	.8308^{-2}
9.66	.2966^{-4}	.5833^{-3}	.5086^{-1}	9.608	.1938^{-2}	455.4	2.386391	101.363	5.942	.3883	108.7	5.695	19.09	.3578^{-2}	.8291^{-2}
9.67	.2946^{-4}	.5804^{-3}	.5076^{-1}	9.618	.1928^{-2}	457.7	2.386516	101.392	5.936	.3882	108.9	5.695	19.13	.3560^{-2}	.8275^{-2}
9.68	.2926^{-4}	.5776^{-3}	.5066^{-1}	9.628	.1919^{-2}	459.9	2.386641	101.421	5.930	.3882	109.2	5.696	19.16	.3543^{-2}	.8257^{-2}
9.69	.2906^{-4}	.5747^{-3}	.5056^{-1}	9.638	.1910^{-2}	462.1	2.386766	101.450	5.923	.3882	109.4	5.697	19.20	.3526^{-2}	.8240^{-2}
9.70	.2886^{-4}	.5719^{-3}	.5046^{-1}	9.648	.1901^{-2}	464.4	2.386890	101.479	5.917	.3882	109.6	5.697	19.24	.3510^{-2}	.8224^{-2}
9.71	.2866^{-4}	.5691^{-3}	.5036^{-1}	9.658	.1892^{-2}	466.6	2.387014	101.507	5.911	.3882	109.8	5.698	19.28	.3493^{-2}	.8206^{-2}
9.72	.2847^{-4}	.5664^{-3}	.5026^{-1}	9.668	.1883^{-2}	468.9	2.387138	101.536	5.905	.3881	110.1	5.698	19.31	.3476^{-2}	.8190^{-2}
9.73	.2827^{-4}	.5636^{-3}	.5016^{-1}	9.678	.1874^{-2}	471.2	2.387261	101.564	5.899	.3881	110.3	5.699	19.35	.3459^{-2}	.8174^{-2}
9.74	.2808^{-4}	.5609^{-3}	.5007^{-1}	9.689	.1865^{-2}	473.4	2.387384	101.593	5.893	.3881	110.5	5.700	19.39	.3443^{-2}	.8155^{-2}
9.75	.2789^{-4}	.5581^{-3}	.4997^{-1}	9.699	.1856^{-2}	475.7	2.387507	101.621	5.887	.3881	110.7	5.700	19.43	.3427^{-2}	.8139^{-2}
9.76	.2770^{-4}	.5554^{-3}	.4987^{-1}	9.709	.1847^{-2}	478.0	2.387629	101.650	5.881	.3880	111.0	5.701	19.47	.3410^{-2}	.8123^{-2}
9.77	.2751^{-4}	.5527^{-3}	.4977^{-1}	9.719	.1838^{-2}	480.3	2.387751	101.678	5.875	.3880	111.2	5.701	19.50	.3394^{-2}	.8107^{-2}
9.78	.2733^{-4}	.5501^{-3}	.4968^{-1}	9.729	.1830^{-2}	482.6	2.387872	101.707	5.869	.3880	111.4	5.702	19.54	.3378^{-2}	.8090^{-2}
9.79	.2714^{-4}	.5474^{-3}	.4958^{-1}	9.739	.1821^{-2}	485.0	2.387993	101.735	5.863	.3880	111.7	5.703	19.58	.3362^{-2}	.8073^{-2}
9.80	.2696^{-4}	.5447^{-3}	.4949^{-1}	9.749	.1812^{-2}	487.3	2.388114	101.763	5.857	.3880	111.9	5.703	19.62	.3346^{-2}	.8057^{-2}
9.81	.2677^{-4}	.5421^{-3}	.4939^{-1}	9.759	.1804^{-2}	489.6	2.388234	101.791	5.851	.3879	112.1	5.704	19.66	.3330^{-2}	.8040^{-2}
9.82	.2659^{-4}	.5395^{-3}	.4929^{-1}	9.769	.1795^{-2}	492.0	2.388354	101.820	5.845	.3879	112.3	5.704	19.69	.3314^{-2}	.8025^{-2}
9.83	.2641^{-4}	.5369^{-3}	.4920^{-1}	9.779	.1787^{-2}	494.4	2.388474	101.848	5.839	.3879	112.6	5.705	19.73	.3298^{-2}	.8008^{-2}
9.84	.2624^{-4}	.5343^{-3}	.4910^{-1}	9.789	.1778^{-2}	496.7	2.388593	101.876	5.833	.3879	112.8	5.705	19.77	.3283^{-2}	.7992^{-2}
9.85	.2606^{-4}	.5317^{-3}	.4901^{-1}	9.799	.1770^{-2}	499.1	2.388712	101.904	5.827	.3879	113.0	5.706	19.81	.3267^{-2}	.7977^{-2}
9.86	.2588^{-4}	.5292^{-3}	.4891^{-1}	9.809	.1762^{-2}	501.5	2.388831	101.932	5.821	.3878	113.3	5.707	19.85	.3252^{-2}	.7960^{-2}
9.87	.2571^{-4}	.5266^{-3}	.4882^{-1}	9.819	.1753^{-2}	503.9	2.388049	101.960	5.815	.3878	113.5	5.707	19.89	.3237^{-2}	.7944^{-2}
9.88	.2554^{-4}	.5241^{-3}	.4873^{-1}	9.820	.1745^{-2}	506.3	2.389067	101.987	5.809	.3878	113.7	5.708	19.92	.3221^{-2}	.7928^{-2}
9.89	.2537^{-4}	.5216^{-3}	.4863^{-1}	9.839	.1737^{-2}	508.7	2.380185	102.015	5.803	.3878	113.9	5.708	19.96	.3206^{-2}	.7912^{-2}
9.90	.2520^{-4}	.5191^{-3}	.4854^{-1}	9.849	.1729^{-2}	511.2	2.389302	102.043	5.797	.3878	114.2	5.709	20.00	.3191^{-2}	.7896^{-2}
9.91	.2503^{-4}	.5166^{-3}	.4845^{-1}	9.859	.1720^{-2}	513.6	2.389419	102.070	5.792	.3877	114.4	5.709	20.04	.3176^{-2}	.7880^{-2}
9.92	.2486^{-4}	.5141^{-3}	.4835^{-1}	9.869	.1712^{-2}	516.0	2.389536	102.098	5.786	.3877	114.6	5.710	20.08	.3161^{-2}	.7864^{-2}
9.93	.2469^{-4}	.5117^{-3}	.4826^{-1}	9.880	.1704^{-2}	518.5	2.389652	102.126	5.780	.3877	114.9	5.710	20.12	.3146^{-2}	.7848^{-2}
9.94	.2453^{-4}	.5092^{-3}	.4817^{-1}	9.890	.1696^{-2}	521.0	2.389768	102.153	5.774	.3877	115.1	5.711	20.15	.3132^{-2}	.7831^{-2}
9.95	.2436^{-4}	.5068^{-3}	.4808^{-1}	9.900	.1689^{-2}	523.4	2.389884	102.180	5.768	.3877	115.3	5.712	20.19	.3117^{-2}	.7817^{-2}
9.96	.2420^{-4}	.5044^{-3}	.4798^{-1}	9.910	.1681^{-2}	525.9	2.389999	102.208	5.762	.3877	115.6	5.712	20.23	.3102^{-2}	.7801^{-2}
9.97	.2404^{-4}	.5020^{-3}	.4789^{-1}	9.920	.1673^{-2}	528.4	2.390114	102.235	5.756	.3876	115.8	5.713	20.27	.3088^{-2}	.7785^{-2}
9.98	.2388^{-4}	.4996^{-3}	.4780^{-1}	9.930	.1665^{-2}	530.9	2.390229	102.262	5.751	.3876	116.0	5.713	20.31	.3073^{-2}	.7770^{-2}
9.99	.2372^{-4}	.4972^{-3}	.4771^{-1}	9.940	.1657^{-2}	533.4	2.390343	102.290	5.745	.3876	116.3	5.714	20.35	.3059^{-2}	.7755^{-2}
10.00	.2356^{-4}	.4948^{-3}	.4762^{-1}	9.950	.1649^{-2}	535.9	2.390457	102.32	5.739	.3876	116.5	5.714	20.39	.3045^{-2}	.7739^{-2}
10.02	.2325^{-4}	.4901^{-3}	.4744^{-1}	9.970	.1634^{-2}	541.0	2.390684	102.37	5.728	.3875	117.0	5.715	20.47	.3016^{-2}	.7708^{-2}
10.04	.2294^{-4}	.4855^{-3}	.4726^{-1}	9.990	.1619^{-2}	546.1	2.390910	102.42	5.716	.3875	117.4	5.717	20.54	.2988^{-2}	.7678^{-2}
10.06	.2264^{-4}	.4809^{-3}	.4708^{-1}	10.01	.1604^{-2}	551.3	2.391134	102.48	5.705	.3875	117.9	5.718	20.62	.2961^{-2}	.7646^{-2}
10.08	.2234^{-4}	.4764^{-3}	.4690^{-1}	10.03	.1589^{-2}	556.4	2.391356	102.53	5.693	.3874	118.4	5.719	20.70	.2934^{-2}	.7616^{-2}
10.10	.2205^{-4}	.4719^{-3}	.4673^{-1}	10.05	.1575^{-2}	561.7	2.391579	102.59	5.682	.3874	118.9	5.720	20.78	.2906^{-2}	.7588^{-2}
10.12	.2176^{-4}	.4675^{-3}	.4655^{-1}	10.07	.1560^{-2}	567.0	2.391800	102.64	5.671	.3874	119.3	5.721	20.86	.2879^{-2}	.7558^{-2}
10.14	.2148^{-4}	.4631^{-3}	.4637^{-1}	10.09	.1546^{-2}	572.3	2.392020	102.70	5.660	.3873	119.8	5.722	20.94	.2853^{-2}	.7528^{-2}
10.16	.2120^{-4}	.4588^{-3}	.4620^{-1}	10.11	.1532^{-2}	577.6	2.392238	102.75	5.648	.3873	120.3	5.723	21.01	.2827^{-2}	.7498^{-2}
10.18	.2092^{-4}	.4545^{-3}	.4603^{-1}	10.13	.1518^{-2}	583.0	2.392455	102.80	5.637	.3872	120.7	5.724	21.09	.2801^{-2}	.7469^{-2}
10.20	.2065^{-4}	.4503^{-3}	.4586^{-1}	10.15	.1504^{-2}	588.4	2.392670	102.85	5.626	.3872	121.2	5.725	21.17	.2775^{-2}	.7439^{-2}
10.22	.2038^{-4}	.4461^{-3}	.4568^{-1}	10.17	.1490^{-2}	593.9	2.392885	102.90	5.615	.3872	121.7	5.726	21.25	.2750^{-2}	.7411^{-2}
10.24	.2011^{-4}	.4419^{-3}	.4551^{-1}	10.19	.1476^{-2}	599.5	2.393098	102.95	5.604	.3871	122.2	5.727	21.33	.2725^{-2}	.7382^{-2}
10.26	.1985^{-4}	.4378^{-3}	.4534^{-1}	10.21	.1463^{-2}	605.0	2.393310	103.01	5.593	.3871	122.7	5.728	21.41	.2700^{-2}	.7354^{-2}
10.28	.1960^{-4}	.4338^{-3}	.4518^{-1}	10.23	.1450^{-2}	610.6	2.393521	103.06	5.582	.3871	123.1	5.729	21.49	.2676^{-2}	.7324^{-2}
10.30	.1934^{-4}	.4298^{-3}	.4501^{-1}	10.25	.1437^{-2}	616.2	2.393731	103.11	5.571	.3870	123.6	5.730	21.57	.2651^{-2}	.7297^{-2}
10.32	.1909^{-4}	.4258^{-3}	.4484^{-1}	10.27	.1424^{-2}	621.9	2.393940	103.16	5.561	.3870	124.1	5.731	21.65	.2627^{-2}	.7268^{-2}
10.34	.1885^{-4}	.4219^{-3}	.4468^{-1}	10.29	.1411^{-2}	627.6	2.394147	103.21	5.550	.3870	124.6	5.732	21.73	.2603^{-2}	.7240^{-2}
10.36	.1861^{-4}	.4180^{-3}	.4451^{-1}	10.31	.1398^{-2}	633.4	2.394354	103.27	5.539	.3869	125.1	5.733	21.81	.2580^{-2}	.7213^{-2}
10.38	.1837^{-4}	.4142^{-3}	.4435^{-1}	10.33	.1385^{-2}	639.2	2.394559	103.31	5.528	.3869	125.5	5.734	21.89	.2557^{-2}	.7185^{-2}
10.40	.1813^{-4}	.4104^{-3}	.4419^{-1}	10.35	.1373^{-2}	645.1	2.394763	103.36	5.518	.3869	126.0	5.735	21.97	.2534^{-2}	.7157^{-2}
10.42	.1790^{-4}	.4066^{-3}	.4402^{-1}	10.37	.1361^{-2}	651.0	2.394966	103.41	5.507	.3868	126.5	5.736	22.06	.2511^{-2}	.7130^{-2}
10.44	.1767^{-4}	.4029^{-3}	.4386^{-1}	10.39	.1348^{-2}	656.9	2.395167	103.47	5.497	.3868	127.0	5.737	22.14	.2488^{-2}	.7102^{-2}
10.46	.1745^{-4}	.3993^{-3}	.4370^{-1}	10.41	.1336^{-2}	662.9	2.395368	103.52	5.486	.3868	127.5	5.738	22.22	.2466^{-2}	.7075^{-2}
10.48	.1723^{-4}	.3456^{-3}	.4354^{-1}	10.43	.1324^{-2}	668.9	2.395568	103.56	5.476	.3867	128.0	5.739	22.30	.2444^{-2}	.7049^{-2}

TABLE II.—SUPERSONIC FLOW—Continued

$\gamma=7/5$

M or M_1	$\frac{p}{p_t}$	$\frac{\rho}{\rho_t}$	$\frac{T}{T_t}$	β	$\frac{q}{p_t}$	$\frac{A}{A_*}$	$\frac{V}{a_*}$	ν	μ	M_2	$\frac{p_2}{p_1}$	$\frac{\rho_2}{\rho_1}$	$\frac{T_2}{T_1}$	$\frac{p_{t_2}}{p_{t_1}}$	$\frac{p_1}{p_{t_2}}$
10.50	.1701 -4	.3920 -3	.4338 -1	10.45	.1313 -2	675.0	2.395766	103.61	5.465	.3867	128.5	5.740	22.38	.2422 -2	.7022 -2
10.52	.1679 -4	.3885 -3	.4323 -1	10.47	.1301 -2	681.1	2.395964	103.66	5.455	.3867	129.0	5.741	22.46	.2400 -2	.6996 -2
10.54	.1658 -4	.3850 -3	.4307 -1	10.49	.1289 -2	687.3	2.396160	103.71	5.444	.3866	129.4	5.742	22.54	.2379 -2	.6968 -2
10.56	.1637 -4	.3815 -3	.4291 -1	10.51	.1278 -2	693.5	2.396355	103.76	5.434	.3866	129.9	5.743	22.63	.2358 -2	.6942 -2
10.58	.1616 -4	.3780 -3	.4276 -1	10.53	.1267 -2	699.7	2.396550	103.81	5.424	.3866	130.4	5.744	22.71	.2337 -2	.6917 -2
10.60	.1596 -4	.3747 -3	.4260 -1	10.55	.1255 -2	706.0	2.396743	103.86	5.413	.3865	130.9	5.744	22.79	.2317 -2	.6891 -2
10.62	.1576 -4	.3713 -3	.4245 -1	10.57	.1244 -2	712.3	2.396935	103.90	5.403	.3865	131.4	5.745	22.87	.2296 -2	.6866 -2
10.64	.1556 -4	.3680 -3	.4230 -1	10.59	.1233 -2	718.7	2.397126	103.96	5.393	.3865	131.9	5.746	22.96	.2276 -2	.6839 -2
10.66	.1537 -4	.3647 -3	.4215 -1	10.61	.1223 -2	725.2	2.397316	104.01	5.383	.3864	132.4	5.747	23.04	.2256 -2	.6814 -2
10.68	.1518 -4	.3614 -3	.4200 -1	10.63	.1212 -2	731.6	2.397505	104.05	5.373	.3864	132.9	5.748	23.12	.2236 -2	.6789 -2
10.70	.1499 -4	.3582 -3	.4185 -1	10.65	.1201 -2	738.2	2.397693	104.10	5.363	.3864	133.4	5.749	23.21	.2216 -2	.6763 -2
10.72	.1480 -4	.3550 -3	.4170 -1	10.67	.1191 -2	744.8	2.397880	104.14	5.353	.3863	133.9	5.750	23.29	.2197 -2	.6737 -2
10.74	.1462 -4	.3518 -3	.4155 -1	10.69	.1180 -2	751.4	2.398066	104.19	5.343	.3863	134.4	5.751	23.37	.2178 -2	.6712 -2
10.76	.1444 -4	.3487 -3	.4140 -1	10.71	.1170 -2	758.1	2.398251	104.24	5.333	.3863	134.9	5.752	23.46	.2159 -2	.6688 -2
10.78	.1426 -4	.3456 -3	.4125 -1	10.73	.1160 -2	764.8	2.398435	104.29	5.323	.3862	135.4	5.753	23.54	.2140 -2	.6663 -2
10.80	.1408 -4	.3426 -3	.4111 -1	10.75	.1150 -2	771.5	2.398618	104.33	5.313	.3862	135.9	5.753	23.62	.2121 -2	.6638 -2
10.82	.1391 -4	.3395 -3	.4096 -1	10.77	.1140 -2	778.4	2.398801	104.38	5.303	.3862	136.4	5.754	23.71	.2103 -2	.6614 -2
10.84	.1374 -4	.3365 -3	.4081 -1	10.79	.1130 -2	785.2	2.398982	104.43	5.293	.3862	136.9	5.755	23.79	.2085 -2	.6589 -2
10.86	.1357 -4	.3336 -3	.4067 -1	10.81	.1120 -2	792.1	2.399162	104.48	5.283	.3861	137.4	5.756	23.88	.2067 -2	.6565 -2
10.88	.1340 -4	.3306 -3	.4053 -1	10.83	.1110 -2	799.1	2.399341	104.52	5.274	.3861	137.9	5.757	23.96	.2048 -2	.6542 -2
10.90	.1324 -4	.3277 -3	.4038 -1	10.85	.1161 -2	806.1	2.399519	104.57	5.264	.3861	138.5	5.758	24.05	.2031 -2	.6518 -2
10.92	.1307 -4	.3249 -3	.4024 -1	10.87	.1091 -2	813.1	2.399697	104.61	5.254	.3860	139.0	5.759	24.13	.2013 -2	.6494 -2
10.94	.1291 -4	.3220 -3	.4010 -1	10.89	.1082 -2	820.3	2.399873	104.66	5.245	.3860	139.5	5.759	24.21	.1996 -2	.6469 -2
10.96	.1276 -4	.3192 -3	.3996 -1	10.91	.1073 -2	827.4	2.400049	104.71	5.235	.3860	140.0	5.760	24.30	.1979 -2	.6447 -2
10.98	.1260 -4	.3165 -3	.3982 -1	10.93	.1064 -2	834.6	2.400223	104.75	5.225	.3860	140.5	5.761	24.39	.1962 -2	.6424 -2
11.00	.1245 -4	.3137 -3	.3968 -1	10.95	.1054 -2	841.9	2.400397	104.80	5.216	.3859	141.0	5.762	24.47	.1945 -2	.6400 -2
11.02	.1230 -4	.3109 -3	.3954 -1	10.97	.1045 -2	849.2	2.400570	104.85	5.206	.3859	141.5	5.763	24.56	.1929 -2	.6376 -2
11.04	.1215 -4	.3083 -3	.3941 -1	11.00	.1036 -2	856.6	2.400741	104.89	5.197	.3859	142.0	5.764	24.64	.1912 -2	.6354 -2
11.06	.1200 -4	.3056 -3	.3927 -1	11.02	.1028 -2	864.0	2.400912	104.93	5.188	.3858	142.5	5.764	24.73	.1896 -2	.6330 -2
11.08	.1186 -4	.3030 -3	.3913 -1	11.04	.1019 -2	871.5	2.401082	104.98	5.178	.3858	143.1	5.765	24.81	.1880 -2	.6308 -2
11.10	.1171 -4	.3003 -3	.3900 -1	11.06	.1010 -2	879.0	2.401252	105.02	5.169	.3858	143.6	5.766	24.90	.1864 -2	.6286 -2
11.12	.1157 -4	.2978 -3	.3886 -1	11.08	.1002 -2	886.6	2.401420	105.06	5.159	.3858	144.1	5.767	24.99	.1848 -2	.6263 -2
11.14	.1143 -4	.2952 -3	.3873 -1	11.10	.9932 -3	894.2	2.401587	105.11	5.150	.3857	144.6	5.768	25.08	.1832 -2	.6241 -2
11.16	.1130 -4	.2927 -3	.3860 -1	11.12	.9847 -3	901.9	2.401754	105.16	5.141	.3857	145.1	5.768	25.16	.1817 -2	.6218 -2
11.18	.1116 -4	.2902 -3	.3846 -1	11.14	.9765 -3	909.6	2.401919	105.20	5.132	.3857	145.7	5.769	25.25	.1801 -2	.6197 -2
11.20	.1103 -4	.2877 -3	.3833 -1	11.16	.9683 -3	917.4	2.402084	105.24	5.123	.3856	146.2	5.770	25.33	.1786 -2	.6174 -2
11.22	.1090 -4	.2852 -3	.3820 -1	11.18	.9602 -3	925.2	2.402248	105.28	5.113	.3856	146.7	5.771	25.42	.1771 -2	.6152 -2
11.24	.1077 -4	.2828 -3	.3807 -1	11.20	.9521 -3	933.1	2.402412	105.33	5.104	.3856	147.2	5.772	25.51	.1756 -2	.6131
11.26	.1064 -4	.2804 -3	.3794 -1	11.22	.9440 -3	941.1	2.402574	105.37	5.095	.3856	147.8	5.772	25.60	.1742 -2	.6108
11.28	.1051 -4	.2780 -3	.3781 -1	11.24	.9362 -3	949.1	2.402735	105.42	5.086	.3855	148.3	5.773	25.69	.1727 -2	.6087
11.30	.1039 -4	.2756 -3	.3768 -1	11.26	.9283 -3	957.1	2.402896	105.46	5.077	.3855	148.8	5.774	25.77	.1712 -2	.6066
11.32	.1026 -4	.2733 -3	.3755 -1	11.28	.9206 -3	965.3	2.403056	105.50	5.068	.3855	149.3	5.775	25.86	.1698 -2	.6044 -2
11.34	.1014 -4	.2710 -3	.3743 -1	11.30	.9130 -3	973.5	2.403215	105.55	5.059	.3855	149.9	5.775	25.95	.1684 -2	.6023 -2
11.36	.1002 -4	.2687 -3	.3730 -1	11.32	.9054 -3	981.6	2.403373	105.59	5.050	.3854	150.4	5.776	26.04	.1670 -2	.6002 -2
11.38	.9905 -5	.2664 -3	.3717 -1	11.34	.8979 -3	989.9	2.403531	105.63	5.041	.3854	150.9	5.777	26.12	.1656 -2	.5981 -2
11.40	.9788 -5	.2642 -3	.3705 -1	11.36	.8904 -3	998.3	2.403687	105.67	5.032	.3854	151.5	5.778	26.21	.1642 -2	.5959 -2
11.42	.9673 -5	.2620 -3	.3692 -1	11.38	.8830 -3	1007	2.403843	105.71	5.024	.3854	152.0	5.779	26.30	.1629 -2	.5939 -2
11.44	.9559 -5	.2598 -3	.3680 -1	11.40	.8757 -3	1015	2.403998	105.75	5.015	.3853	152.5	5.779	26.39	.1615 -2	.5918 -2
11.46	.9447 -5	.2576 -3	.3668 -1	11.42	.8685 -3	1024	2.404152	105.80	5.006	.3853	153.1	5.780	26.48	.1602 -2	.5897 -2
11.48	.9337 -5	.2554 -3	.3655 -1	11.44	.8613 -3	1032	2.404306	105.84	4.997	.3853	153.6	5.781	26.57	.1589 -2	.5877 -2
11.50	.9228 -5	.2533 -3	.3643 -1	11.46	.8543 -3	1041	2.404459	105.88	4.989	.3853	154.1	5.781	26.66	.1575 -2	.5858 -2
11.52	.9120 -5	.2512 -3	.3631 -1	11.48	.8472 -3	1050	2.404610	105.92	4.980	.3852	154.7	5.782	26.75	.1563 -2	.5836 -2
11.54	.9014 -5	.2491 -3	.3619 -1	11.50	.8403 -3	1058	2.404762	105.97	4.971	.3852	155.2	5.783	26.84	.1550 -2	.5816 -2
11.56	.8909 -5	.2470 -3	.3607 -1	11.52	.8334 -3	1067	2.404912	106.01	4.963	.3852	155.7	5.784	26.93	.1537 -2	.5797 -2
11.58	.8806 -5	.2450 -3	.3595 -1	11.54	.8266 -3	1076	2.405062	106.05	4.954	.3852	156.3	5.784	27.02	.1525 -2	.5776 -2
11.60	.8704 -5	.2430 -3	.3583 -1	11.56	.8199 -3	1085	2.405211	106.09	4.945	.3851	156.8	5.785	27.11	.1512 -2	.5757 -2
11.62	.8604 -5	.2409 -3	.3571 -1	11.58	.8132 -3	1094	2.405359	106.13	4.937	.3851	157.4	5.786	27.20	.1500 -2	.5737 -2
11.64	.8505 -5	.2390 -3	.3559 -1	11.60	.8066 -3	1103-	2.405506	106.17	4.928	.3851	157.9	5.787	27.29	.1488 -2	.5717 -2
11.66	.8406 -5	.2370 -3	.3547 -1	11.62	.8000 -3	1112	2.405653	106.21	4.920	.3851	158.5	5.787	27.38	.1475 -2	.5698 -2
11.68	.8310 -5	.2350 -3	.3536 -1	11.64	.7935 -3	1121	2.405799	106.25	4.912	.3850	159.0	5.788	27.47	.1464 -2	.5678 -2
11.70	.8215 -5	.2331 -3	.3524 -1	11.66	.7871 -3	1130	2.405944	106.29	4.903	.3850	159.5	5.789	27.56	.1452 -2	.5659 -2
11.72	.8120 -5	.2312 -3	.3512 -1	11.68	.7808 -3	1140	2.406089	106.33	4.895	.3850	160.1	5.789	27.65	.1440 -2	.5639 -2
11.74	.8027 -5	.2293 -3	.3501 -1	11.70	.7744 -3	1149	2.406233	106.37	4.886	.3850	160.6	5.790	27.74	.1428 -2	.5620 -2
11.76	.7935 -5	.2274 -3	.3489 -1	11.72	.7682 -3	1158	2.406376	106.41	4.878	.3849	161.2	5.791	27.84	.1417 -2	.5601 -2
11.78	.7845 -5	.2256 -3	.3478 -1	11.74	.7620 -3	1168	2.406518	106.45	4.870	.3849	161.7	5.791	27.93	.1405 -2	.5583 -2
11.80	.7755 -5	.2237 -3	.3466 -1	11.76	.7559 -3	1177	2.406660	106.49	4.861	.3849	162.3	5.792	28.02	.1394 -2	.5564 -2
11.82	.7667 -5	.2219 -3	.3455 -1	11.78	.7498 -3	1187	2.406801	106.53	4.853	.3849	162.8	5.793	28.11	.1383 -2	.5544 -2
11.84	.7580 -5	.2201 -3	.3444 -1	11.80	.7438 -3	1197	2.406942	106.57	4.845	.3848	163.4	5.793	28.20	.1372 -2	.5526 -2
11.86	.7494 -5	.2183 -3	.3433 -1	11.82	.7379 -3	1206	2.407081	106.61	4.837	.3848	163.9	5.794	28.30	.1361 -2	.5508 -2
11.88	.7409 -5	.2165 -3	.3422 -1	11.84	.7320 -3	1216	2.407220	106.65	4.829	.3848	164.5	5.795	28.39	.1350 -2	.5489 -2
11.90	.7325 -5	.2148 -3	.3410 -1	11.86	.7261 -3	1226	2.407359	106.69	4.820	.3848	165.1	5.795	28.48	.1339 -2	.5471 -2
11.92	.7243 -5	.2131 -3	.3399 -1	11.88	.7201 -3	1236	2.407496	106.73	4.812	.3848	165.6	5.796	28.57	.1328 -2	.5153 -2
11.94	.7161 -5	.2113 -3	.3388 -1	11.90	.7146 -3	1246	2.407633	106.76	4.801	.3847	166.2	5.797	28.67	.1318 -2	.5135 -2
11.96	.7080 -5	.2096 -3	.3377 -1	11.92	.7089 -3	1256	2.407770	106.81	4.796	.3847	166.7	5.797	28.76	.1307 -2	.5116 -2
11.98	.7000 -5	.2079 -3	.3367 -1	11.94	.7033 -3	1266	2.407905	106.84	4.788	.3847	167.3	5.798	28.85	.1297 -2	.5397 -2
12.00	.6922 -5	.2063 -3	.3356 -1	11.96	.6978 -3	1276	2.408040	106.88	4.780	.3847	167.8	5.799	28.94	.1287 -2	.5380 -2
12.02	.6845 -5	.2046 -3	.3345 -1	11.98	.6922 -3	1287	2.408175	106.92	4.772	.3846	168.4	5.799	29.04	.1277 -2	.5362 -2
12.04	.6768 -5	.2030 -3	.3334 -1	12.00	.6868 -3	1297	2.408308	106.95	4.764	.3846	169.0	5.800	29.13	.1266 -2	.5345 -2
12.06	.6692 -5	.2014 -3	.3324 -1	12.02	.6814 -3	1307	2.408441	106.99	4.756	.3846	169.5	5.801	29.23	.1256 -2	.5327 -2
12.08	.6618 -5	.1998 -3	.3313 -1	12.04	.6760 -3	1318	2.408574	107.03	4.748	.3846	170.1	5.801	29.32	.1247 -2	.5309 -2
12.10	.6544 -5	.1982 -3	.3302 -1	12.06	.6707 -3	1328	2.408706	107.07	4.741	.3846	170.7	5.802	29.41	.1237 -2	.5292
12.12	.6472 -5	.1966 -3	.3292 -1	12.08	.6655 -3	1339	2.408837	107.11	4.733	.3845	171.2	5.803	29.51	.1227 -2	.5275
12.14	.6400 -5	.1950 -3	.3281 -1	12.10	.6602 -3	1349	2.408967	107.14	4.725	.3845	171.8	5.803	29.60	.1217 -2	.5257
12.16	.6328 -5	.1935 -3	.3271 -1	12.12	.6550 -3	1360	2.409097	107.18	4.717	.3845	172.3	5.804	29.70	.1208 -2	.5240
12.18	.6259 -5	.1920 -3	.3261 -1	12.14	.6500 -3	1371	2.409226	107.22	4.709	.3845	172.9	5.804	29.79	.1198 -2	.5223
12.20	.6189 -5	.1904 -3	.3250 -1	12.16	.6448 -3	1382	2.409355	107.26	4.702	.3844	173.5	5.805	29.89	.1189 -2	.5205 -2
12.22	.6122 -5	.1889 -3	.3240 -1	12.18	.6399 -3	1393	2.409483	107.29	4.694	.3844	174.1	5.806	29.98	.1180 -2	.5189 -2
12.24	.6054 -5	.1874 -3	.3230 -1	12.20	.6349 -3	1404	2.409611	107.33	4.686	.3844	174.6	5.806	30.08	.1171 -2	.5172 -2
12.26	.5987 -5	.1860 -3	.3219 -1	12.22	.6299 -3	1415	2.409738	107.36	4.679	.3844	175.2	5.807	30.17	.1161 -2	.5155 -2
12.28	.5922 -5	.1845 -3	.3209 -1	12.24	.6251 -3	1426	2.409864	107.41	4.671	.3844	175.8	5.807	30.27	.1153 -2	.5138 -2

TABLE II.—SUPERSONIC FLOW—Continued

$\gamma = 7/5$

M or M_1	$\frac{p}{p_t}$	$\frac{\rho}{\rho_t}$	$\frac{T}{T_t}$	β	$\frac{q}{p_t}$	$\frac{A}{A_*}$	$\frac{V}{a_*}$	ν	μ	M_2	$\frac{p_2}{p_1}$	$\frac{\rho_2}{\rho_1}$	$\frac{T_2}{T_1}$	$\frac{p_{t_2}}{p_{t_1}}$	$\frac{p_1}{p_{t_2}}$
12.30	.5857 -5	.1831 -3	.3199 -1	12.26	.6202 -3	1437	2.409989	107.44	4.663	.3843	176.3	5.808	30.36	.1144 -2	.5122 -2
12.32	.5792 -5	.1816 -3	.3189 -1	12.28	.6154 -3	1448	2.410115	107.48	4.656	.3843	176.9	5.809	30.46	.1135 -2	.5105 -2
12.34	.5729 -5	.1802 -3	.3179 -1	12.30	.6107 -3	1460	2.410239	107.51	4.648	.3843	177.5	5.809	30.55	.1126 -2	.5088 -2
12.36	.5667 -5	.1788 -3	.3169 -1	12.32	.6060 -3	1471	2.410363	107.55	4.641	.3843	178.1	5.810	30.65	.1117 -2	.5072 -2
12.38	.5605 -5	.1774 -3	.3159 -1	12.34	.6013 -3	1482	2.410486	107.59	4.633	.3843	178.6	5.810	30.75	.1109 -2	.5056 -2
12.40	.5544 -5	.1760 -3	.3149 -1	12.36	.5967 -3	1494	2.410609	107.62	4.626	.3842	179.2	5.811	30.84	.1100 -2	.5039 -2
12.42	.5484 -5	.1747 -3	.3140 -1	12.38	.5921 -3	1506	2.410731	107.66	4.618	.3842	179.8	5.812	30.94	.1092 -2	.5023 -2
12.44	.5424 -5	.1733 -3	.3130 -1	12.40	.5876 -3	1517	2.410853	107.69	4.611	.3842	180.4	5.812	31.04	.1083 -2	.5007 -2
12.46	.5365 -5	.1720 -3	.3120 -1	12.42	.5831 -3	1529	2.410974	107.73	4.603	.3842	181.0	5.813	31.13	.1075 -2	.4991 -2
12.48	.5307 -5	.1706 -3	.3110 -1	12.44	.5786 -3	1541	2.411094	107.77	4.596	.3842	181.5	5.813	31.23	.1067 -2	.4975 -2
12.50	.5250 -5	.1693 -3	.3101 -1	12.46	.5742 -3	1553	2.411214	107.80	4.589	.3841	182.1	5.814	31.33	.1059 -2	.4960 -2
12.52	.5193 -5	.1680 -3	.3091 -1	12.48	.5698 -3	1565	2.411333	107.84	4.581	.3841	182.7	5.815	31.42	.1051 -2	.4944 -2
12.54	.5137 -5	.1667 -3	.3082 -1	12.50	.5655 -3	1577	2.411452	107.87	4.574	.3841	183.3	5.815	31.52	.1043 -2	.4927 -2
12.56	.5082 -5	.1654 -3	.3072 -1	12.52	.5612 -3	1589	2.411571	107.90	4.567	.3841	183.9	5.816	31.62	.1035 -2	.4912 -2
12.58	.5028 -5	.1642 -3	.3063 -1	12.54	.5570 -3	1601	2.411688	107.94	4.559	.3841	184.5	5.816	31.72	.1027 -2	.4897 -2
12.60	.4973 -5	.1629 -3	.3053 -1	12.56	.5527 -3	1614	2.411805	107.98	4.552	.3840	185.1	5.817	31.81	.1019 -2	.4881 -2
12.62	.4920 -5	.1617 -3	.3044 -1	12.58	.5486 -3	1626	2.411922	108.01	4.545	.3840	185.6	5.817	31.91	.1011 -2	.4865 -2
12.64	.4868 -5	.1604 -3	.3035 -1	12.60	.5444 -3	1639	2.412038	108.05	4.538	.3840	186.2	5.818	32.01	.1004 -2	.4850 -2
12.66	.4816 -5	.1592 -3	.3025 -1	12.62	.5403 -3	1651	2.412154	108.08	4.530	.3840	186.8	5.819	32.11	.9961 -3	.4835 -2
12.68	.4764 -5	.1580 -3	.3016 -1	12.64	.5362 -3	1664	2.412269	108.12	4.523	.3840	187.4	5.819	32.21	.9885 -3	.4820 -2
12.70	.4714 -5	.1568 -3	.3007 -1	12.66	.5322 -3	1676	2.412383	108.15	4.516	.3839	188.0	5.820	32.31	.9810 -3	.4805 -2
12.72	.4663 -5	.1556 -3	.2998 -1	12.68	.5282 -3	1689	2.412497	108.18	4.509	.3839	188.6	5.820	32.41	.9737 -3	.4790 -2
12.74	.4614 -5	.1544 -3	.2989 -1	12.70	.5242 -3	1702	2.412611	108.22	4.502	.3839	189.2	5.821	32.50	.9664 -3	.4775 -2
12.76	.4565 -5	.1532 -3	.2979 -1	12.72	.5203 -3	1715	2.412723	108.25	4.495	.3839	189.8	5.821	32.60	.9591 -3	.4760 -2
12.78	.4517 -5	.1521 -3	.2970 -1	12.74	.5164 -3	1728	2.412836	108.29	4.488	.3839	190.4	5.822	32.70	.9520 -3	.4745 -2
12.80	.4469 -5	.1509 -3	.2961 -1	12.76	.5126 -3	1741	2.412948	108.32	4.481	.3839	191.0	5.822	32.80	.9448 -3	.4730 -2
12.82	.4422 -5	.1498 -3	.2952 -1	12.78	.5087 -3	1754	2.413059	108.35	4.474	.3838	191.6	5.823	32.90	.9378 -3	.4715 -2
12.84	.4376 -5	.1487 -3	.2944 -1	12.80	.5050 -3	1767	2.413170	108.39	4.467	.3838	192.2	5.823	33.00	.9308 -3	.4701 -2
12.86	.4329 -5	.1475 -3	.2935 -1	12.82	.5012 -3	1781	2.413280	108.42	4.460	.3838	192.8	5.824	33.10	.9239 -3	.4686 -2
12.88	.4284 -5	.1464 -3	.2926 -1	12.84	.4975 -3	1794	2.413390	108.45	4.453	.3838	193.4	5.825	33.20	.9170 -3	.4672 -2
12.90	.4239 -5	.1453 -3	.2917 -1	12.86	.4938 -3	1807	2.413500	108.49	4.446	.3838	194.0	5.825	33.30	.9102 -3	.4657 -2
12.92	.4195 -5	.1442 -3	.2908 -1	12.88	.4901 -3	1821	2.413609	108.52	4.439	.3837	194.6	5.826	33.40	.9035 -3	.4643 -2
12.94	.4151 -5	.1432 -3	.2900 -1	12.90	.4865 -3	1835	2.413717	108.55	4.432	.3837	195.2	5.826	33.50	.8968 -3	.4629 -2
12.96	.4107 -5	.1421 -3	.2891 -1	12.92	.4829 -3	1848	2.413825	108.59	4.425	.3837	195.8	5.827	33.60	.8902 -3	.4614 -2
12.98	.4065 -5	.1410 -3	.2882 -1	12.94	.4794 -3	1862	2.413932	108.62	4.419	.3837	196.4	5.827	33.70	.8836 -3	.4600 -2
13.00	.4023 -5	.1400 -3	.2874 -1	12.96	.4759 -3	1876	2.414039	108.65	4.412	.3837	197.0	5.828	33.81	.8771 -3	.4586 -2
13.02	.3981 -5	.1389 -3	.2865 -1	12.98	.4723 -3	1890	2.414146	108.69	4.405	.3837	197.6	5.828	33.91	.8706 -3	.4572 -2
13.04	.3939 -5	.1379 -3	.2857 -1	13.00	.4689 -3	1904	2.414252	108.72	4.398	.3836	198.2	5.829	34.01	.8642 -3	.4559 -2
13.06	.3898 -5	.1369 -3	.2848 -1	13.02	.4655 -3	1918	2.414357	108.75	4.391	.3836	198.8	5.829	34.11	.8580 -3	.4544 -2
13.08	.3858 -5	.1359 -3	.2840 -1	13.04	.4620 -3	1933	2.414462	108.78	4.385	.3836	199.4	5.830	34.21	.8517 -3	.4530 -2
13.10	.3818 -5	.1349 -3	.2831 -1	13.06	.4586 -3	1947	2.414567	108.82	4.378	.3836	200.1	5.830	34.31	.8453 -3	.4517 -2
13.12	.3779 -5	.1339 -3	.2823 -1	13.08	.4553 -3	1961	2.414671	108.85	4.371	.3836	200.7	5.831	34.42	.8392 -3	.4503 -2
13.14	.3740 -5	.1329 -3	.2814 -1	13.10	.4520 -3	1976	2.414775	108.88	4.365	.3836	201.3	5.831	34.52	.8331 -3	.4489 -2
13.16	.3701 -5	.1319 -3	.2806 -1	13.12	.4487 -3	1990	2.414878	108.91	4.358	.3835	201.9	5.832	34.62	.8271 -3	.4475 -2
13.18	.3663 -5	.1309 -3	.2798 -1	13.14	.4454 -3	2005	2.414981	108.94	4.351	.3835	202.5	5.832	34.72	.8210 -3	.4462 -2
13.20	.3626 -5	.1300 -3	.2790 -1	13.16	.4422 -3	2020	2.415083	108.97	4.345	.3835	203.1	5.833	34.82	.8151 -3	.4448 -2
13.22	.3589 -5	.1290 -3	.2781 -1	13.18	.4390 -3	2034	2.415185	109.01	4.338	.3835	203.7	5.833	34.93	.8091 -3	.4435 -2
13.24	.3552 -5	.1281 -3	.2773 -1	13.20	.4358 -3	2049	2.415286	109.04	4.332	.3835	204.4	5.834	35.03	.8032 -3	.4422 -2
13.26	.3516 -5	.1271 -3	.2765 -1	13.22	.4327 -3	2064	2.415387	109.07	4.325	.3835	205.0	5.834	35.13	.7974 -3	.4409 -2
13.28	.3480 -5	.1262 -3	.2757 -1	13.24	.4296 -3	2079	2.415488	109.10	4.319	.3834	205.6	5.835	35.24	.7918 -3	.4395 -2
13.30	.3444 -5	.1253 -3	.2749 -1	13.26	.4264 -3	2095	2.415588	109.13	4.312	.3834	206.2	5.835	35.34	.7860 -3	.4382 -2
13.32	.3409 -5	.1244 -3	.2741 -1	13.28	.4234 -3	2110	2.4156876	109.16	4.306	.3834	206.8	5.836	35.44	.7802 -3	.4369 -2
13.34	.3374 -5	.1235 -3	.2733 -1	13.30	.4203 -3	2125	2.4157868	109.20	4.299	.3834	207.5	5.836	35.55	.7747 -3	.4356 -2
13.36	.3340 -5	.1226 -3	.2725 -1	13.32	.4173 -3	2141	2.4158856	109.23	4.293	.3834	208.1	5.837	35.65	.7691 -3	.4342 -2
13.38	.3306 -5	.1217 -3	.2717 -1	13.34	.4143 -3	2156	2.4159839	109.26	4.286	.3834	208.7	5.837	35.76	.7636 -3	.4330 -2
13.40	.3273 -5	.1208 -3	.2709 -1	13.36	.4113 -3	2172	2.4160818	109.29	4.280	.3833	209.3	5.838	35.86	.7582 -3	.4316 -2
13.42	.3240 -5	.1199 -3	.2701 -1	13.38	.4084 -3	2188	2.4161793	109.32	4.273	.3833	210.0	5.838	35.96	.7527 -3	.4304 -2
13.44	.3207 -5	.1191 -3	.2694 -1	13.40	.4055 -3	2204	2.4162763	109.35	4.267	.3833	210.6	5.838	36.07	.7474 -3	.4291 -2
13.46	.3175 -5	.1182 -3	.2686 -1	13.42	.4026 -3	2219	2.4163730	109.38	4.261	.3833	211.2	5.839	36.17	.7420 -3	.4278 -2
13.48	.3143 -5	.1174 -3	.2678 -1	13.44	.3997 -3	2236	2.4164692	109.41	4.254	.3833	211.8	5.839	36.28	.7367 -3	.4265 -2
13.50	.3111 -5	.1165 -3	.2670 -1	13.46	.3969 -3	2252	2.4165650	109.44	4.248	.3833	212.5	5.840	36.38	.7315 -3	.4253 -2
13.52	.3080 -5	.1157 -3	.2663 -1	13.48	.3941 -3	2268	2.4166604	109.47	4.242	.3832	213.1	5.840	36.49	.7263 -3	.4241 -2
13.54	.3049 -5	.1149 -3	.2655 -1	13.50	.3913 -3	2284	2.4167554	109.51	4.235	.3832	213.7	5.841	36.59	.7212 -3	.4228 -2
13.56	.3019 -5	.1140 -3	.2647 -1	13.52	.3885 -3	2300	2.4168499	109.54	4.229	.3832	214.4	5.841	36.70	.7161 -3	.4216 -2
13.58	.2988 -5	.1132 -3	.2640 -1	13.54	.3858 -3	2317	2.4169441	109.57	4.223	.3832	215.0	5.842	36.80	.7109 -3	.4204 -2
13.60	.2958 -5	.1124 -3	.2632 -1	13.56	.3830 -3	2334	2.4170379	109.59	4.217	.3832	215.6	5.842	36.91	.7059 -3	.4191 -2
13.62	.2929 -5	.1116 -3	.2625 -1	13.58	.3803 -3	2350	2.4171312	109.62	4.211	.3832	216.3	5.843	37.02	.7009 -3	.4179 -2
13.64	.2900 -5	.1108 -3	.2617 -1	13.60	.3777 -3	2367	2.4172242	109.65	4.204	.3832	216.9	5.843	37.12	.6960 -3	.4166 -2
13.66	.2871 -5	.1100 -3	.2610 -1	13.62	.3750 -3	2384	2.4173167	109.69	4.198	.3831	217.5	5.843	37.23	.6911 -3	.4155 -2
13.68	.2842 -5	.1092 -3	.2602 -1	13.64	.3724 -3	2401	2.4174089	109.72	4.192	.3831	218.2	5.844	37.33	.6862 -3	.4142 -2
13.70	.2814 -5	.1085 -3	.2595 -1	13.66	.3697 -3	2418	2.4175007	109.75	4.186	.3831	218.8	5.844	37.44	.6814 -3	.4130 -2
13.72	.2787 -5	.1077 -3	.2588 -1	13.68	.3672 -3	2435	2.4175921	109.77	4.180	.3831	219.4	5.845	37.55	.6767 -3	.4118 -2
13.74	.2759 -5	.1069 -3	.2580 -1	13.70	.3646 -3	2452	2.4176831	109.81	4.174	.3831	220.1	5.845	37.65	.6719 -3	.4106 -2
13.76	.2732 -5	.1062 -3	.2573 -1	13.72	.3620 -3	2470	2.4177737	109.84	4.168	.3831	220.7	5.846	37.76	.6672 -3	.4094 -2
13.78	.2705 -5	.1054 -3	.2566 -1	13.74	.3595 -3	2487	2.4178639	109.86	4.162	.3831	221.4	5.846	37.87	.6626 -3	.4082 -2
13.80	.2678 -5	.1047 -3	.2558 -1	13.76	.3570 -3	2505	2.4179537	109.89	4.156	.3830	222.0	5.847	37.97	.6580 -3	.4070 -2
13.82	.2652 -5	.1040 -3	.2551 -1	13.78	.3545 -3	2522	2.4180432	109.92	4.150	.3830	222.7	5.847	38.08	.6533 -3	.4059 -2
13.84	.2626 -5	.1032 -3	.2544 -1	13.80	.3521 -3	2540	2.4181323	109.95	4.144	.3830	223.3	5.847	38.19	.6489 -3	.4047 -2
13.86	.2600 -5	.1025 -3	.2537 -1	13.82	.3497 -3	2558	2.4182210	109.98	4.137	.3830	224.0	5.848	38.30	.6443 -3	.4036 -2
13.88	.2575 -5	.1018 -3	.2530 -1	13.84	.3472 -3	2576	2.4183093	110.01	4.132	.3830	224.6	5.848	38.41	.6398 -3	.4024 -2
13.90	.2550 -5	.1011 -3	.2523 -1	13.86	.3448 -3	2594	2.4183973	110.04	4.126	.3830	225.3	5.849	38.51	.6354 -3	.4013 -2
13.92	.2525 -5	.1004 -3	.2516 -1	13.88	.3424 -3	2612	2.4184849	110.07	4.120	.3830	225.9	5.849	38.62	.6310 -3	.4001 -2
13.94	.2500 -5	.9966 -4	.2509 -1	13.90	.3401 -3	2630	2.4185721	110.09	4.114	.3829	226.5	5.850	38.73	.6267 -3	.3989 -2
13.96	.2476 -5	.9897 -4	.2502 -1	13.92	.3377 -3	2648	2.4186590	110.12	4.108	.3829	227.2	5.850	38.84	.6223 -3	.3978 -2
13.98	.2452 -5	.9826 -4	.2495 -1	13.94	.3354 -3	2667	2.4187455	110.15	4.102	.3829	227.9	5.850	38.95	.6180 -3	.3967 -2
14.00	.2428 -5	.9760 -4	.2488 -1	13.96	.3331 -3	2685	2.4188316	110.18	4.096	.3829	228.5	5.851	39.06	.6138 -3	.3956 -2
14.02	.2404 -5	.9692 -4	.2481 -1	13.98	.3308 -3	2704	2.4189174	110.21	4.090	.3829	229.2	5.851	39.16	.6096 -3	.3944 -2
14.04	.2381 -5	.9625 -4	.2474 -1	14.00	.3286 -3	2723	2.4190028	110.24	4.084	.3829	229.8	5.852	39.27	.6054 -3	.3933 -2
14.06	.2358 -5	.9558 -4	.2467 -1	14.02	.3263 -3	2742	2.4190879	110.26	4.079	.3829	230.5	5.852	39.38	.6013 -3	.3922 -2
14.08	.2335 -5	.9493 -4	.2460 -1	14.04	.3241 -3	2761	2.4191726	110.29	4.073	.3828	231.1	5.852	39.49	.5971 -3	.3911 -2

TABLE II.—SUPERSONIC FLOW—Continued

$\gamma=7/5$

M or M_1	$\frac{p}{p_t}$	$\frac{\rho}{\rho_t}$	$\frac{T}{T_t}$	β	$\frac{q}{p_t}$	$\frac{A}{A_*}$	$\frac{V}{a_*}$	ν	μ	M_2	$\frac{p_2}{p_1}$	$\frac{\rho_2}{\rho_1}$	$\frac{T_2}{T_1}$	$\frac{p_{t_2}}{p_{t_1}}$	$\frac{p_1}{p_{t_2}}$
14.10	.2313 -5	.9427 -4	.2453 -1	14.06	.3219 -3	2780	2.4192569	110.32	4.067	.3828	231.8	5.853	39.60	.5931 -3	.3900 -2
14.12	.2290 -5	.9362 -4	.2447 -1	14.08	.3197 -3	2799	2.4193409	110.35	4.061	.3828	232.4	5.853	39.71	.5890 -3	.3889 -2
14.14	.2268 -5	.9297 -4	.2440 -1	14.10	.3175 -3	2818	2.4194246	110.38	4.055	.3828	233.1	5.854	39.82	.5849 -3	.3878 -2
14.16	.2246 -5	.9233 -4	.2433 -1	14.13	.3153 -3	2838	2.4195079	110.41	4.050	.3828	233.8	5.854	39.93	.5810 -3	.3867 -2
14.18	.2225 -5	.9170 -4	.2426 -1	14.15	.3132 -3	2857	2.4195909	110.44	4.044	.3828	234.4	5.854	40.04	.5770 -3	.3856 -2
14.20	.2204 -5	.9108 -4	.2420 -1	14.17	.3111 -3	2877	2.4196735	110.46	4.038	.3828	235.1	5.855	40.15	.5732 -3	.3845 -2
14.22	.2183 -5	.9045 -4	.2413 -1	14.19	.3089 -3	2897	2.4197558	110.49	4.033	.3827	235.7	5.855	40.26	.5693 -3	.3834 -2
14.24	.2162 -5	.8983 -4	.2406 -1	14.21	.3068 -3	2916	2.4198378	110.52	4.027	.3827	236.4	5.856	40.37	.5654 -3	.3824 -2
14.26	.2141 -5	.8922 -4	.2400 -1	14.23	.3048 -3	2936	2.4199194	110.54	4.021	.3827	237.1	5.856	40.48	.5616 -3	.3813 -2
14.28	.2121 -5	.8861 -4	.2393 -1	14.25	.3027 -3	2956	2.4200007	110.57	4.016	.3827	237.7	5.856	40.60	.5578 -3	.3802 -2
14.30	.2100 -5	.8800 -4	.2387 -1	14.27	.3006 -3	2977	2.4200816	110.60	4.010	.3827	238.4	5.857	40.71	.5540 -3	.3791 -2
14.32	.2080 -5	.8740 -4	.2380 -1	14.29	.2986 -3	2997	2.4201622	110.63	4.004	.3827	239.1	5.857	40.82	.5503 -3	.3780 -2
14.34	.2061 -5	.8682 -4	.2374 -1	14.31	.2967 -3	3017	2.4202425	110.65	3.999	.3827	239.7	5.858	40.93	.5466 -3	.3771 -2
14.36	.2041 -5	.8623 -4	.2367 -1	14.33	.2946 -3	3038	2.4203225	110.68	3.993	.3827	240.4	5.858	41.04	.5429 -3	.3760 -2
14.38	.2022 -5	.8565 -4	.2361 -1	14.35	.2927 -3	3058	2.4204021	110.71	3.988	.3826	241.1	5.858	41.15	.5393 -3	.3750 -2
14.40	.2003 -5	.8506 -4	.2355 -1	14.37	.2907 -3	3079	2.4204815	110.74	3.982	.3826	241.8	5.859	41.26	.5357 -3	.3739 -2
14.42	.1984 -5	.8449 -4	.2348 -1	14.39	.2888 -3	3100	2.4205604	110.76	3.977	.3826	242.4	5.859	41.38	.5321 -3	.3729 -2
14.44	.1965 -5	.8392 -4	.2342 -1	14.41	.2869 -3	3121	2.4206391	110.79	3.971	.3826	243.1	5.860	41.49	.5285 -3	.3719 -2
14.46	.1947 -5	.8335 -4	.2335 -1	14.43	.2849 -3	3142	2.4207175	110.81	3.966	.3826	243.8	5.860	41.60	.5250 -3	.3708 -2
14.48	.1929 -5	.8280 -4	.2329 -1	14.45	.2830 -3	3163	2.4207955	110.84	3.960	.3826	244.5	5.860	41.71	.5215 -3	.3698 -2
14.50	.1910 -5	.8224 -4	.2323 -1	14.47	.2812 -3	3184	2.4208732	110.87	3.955	.3826	245.1	5.861	41.83	.5180 -3	.3688 -2
14.52	.1892 -5	.8168 -4	.2317 -1	14.49	.2793 -3	3206	2.4209506	110.90	3.949	.3825	245.8	5.861	41.94	.5146 -3	.3677 -2
14.54	.1875 -5	.8114 -4	.2310 -1	14.51	.2774 -3	3227	2.4210277	110.92	3.944	.3825	246.5	5.861	42.05	.5111 -3	.3668 -2
14.56	.1857 -5	.8059 -4	.2304 -1	14.53	.2756 -3	3249	2.4211045	110.95	3.938	.3825	247.2	5.862	42.17	.5078 -3	.3657 -2
14.58	.1840 -5	.8005 -4	.2298 -1	14.55	.2737 -3	3271	2.4211810	110.97	3.933	.3825	247.8	5.862	42.28	.5044 -3	.3647 -2
14.60	.1823 -5	.7952 -4	.2292 -1	14.57	.2720 -3	3292	2.4212572	111.00	3.927	.3825	248.5	5.863	42.39	.5011 -3	.3638 -2
14.62	.1806 -5	.7899 -4	.2286 -1	14.59	.2702 -3	3314	2.4213330	111.03	3.922	.3825	249.2	5.863	42.51	.4978 -3	.3628 -2
14.64	.1789 -5	.7847 -4	.2280 -1	14.61	.2684 -3	3336	2.4214086	111.05	3.917	.3825	249.9	5.863	42.62	.4945 -3	.3618 -2
14.66	.1772 -5	.7794 -4	.2274 -1	14.63	.2666 -3	3359	2.4214838	111.08	3.911	.3825	250.6	5.864	42.73	.4912 -3	.3608 -2
14.68	.1756 -5	.7743 -4	.2268 -1	14.65	.2649 -3	3381	2.4215588	111.10	3.906	.3825	251.3	5.864	42.85	.4880 -3	.3598 -2
14.70	.1739 -5	.7691 -4	.2262 -1	14.67	.2631 -3	3404	2.4216335	111.13	3.901	.3824	251.9	5.864	42.96	.4847 -3	.3588 -2
14.72	.1723 -5	.7640 -4	.2256 -1	14.69	.2614 -3	3426	2.4217078	111.16	3.895	.3824	252.6	5.865	43.08	.4816 -3	.3578 -2
14.74	.1707 -5	.7590 -4	.2250 -1	14.71	.2597 -3	3449	2.4217819	111.18	3.890	.3824	253.3	5.865	43.19	.4784 -3	.3569 -2
14.76	.1692 -5	.7540 -4	.2244 -1	14.73	.2580 -3	3472	2.4218557	111.21	3.885	.3924	254.0	5.865	43.31	.4753 -3	.3559 -2
14.78	.1676 -5	.7490 -4	.2238 -1	14.75	.2563 -3	3494	2.4219292	111.23	3.880	.3824	254.7	5.866	43.42	.4722 -3	.3550 -2
14.80	.1660 -5	.7440 -4	.2232 -1	14.77	.2546 -3	3518	2.4220023	111.26	3.874	.3824	255.4	5.866	43.54	.4691 -3	.3540 -2
14.82	.1645 -5	.7392 -4	.2226 -1	14.79	.2530 -3	3541	2.4220752	111.28	3.869	.3824	256.1	5.866	43.65	.4660 -3	.3531 -2
14.84	.1630 -5	.7343 -4	.2220 -1	14.81	.2513 -3	3564	2.4221479	111.31	3.864	.3824	256.8	5.867	43.77	.4630 -3	.3521
14.86	.1615 -5	.7295 -4	.2214 -1	14.83	.2497 -3	3588	2.4222202	111.34	3.859	.3823	257.5	5.867	43.88	.4600 -3	.3512
14.88	.1600 -5	.7247 -4	.2208 -1	14.85	.2480 -3	3611	2.4222922	111.36	3.853	.3823	258.2	5.868	44.00	.4570 -3	.3502
14.90	.1586 -5	.7199 -4	.2203 -1	14.87	.2464 -3	3635	2.4223640	111.38	3.848	.3823	258.9	5.868	44.11	.4540 -3	.3493 -2
14.92	.1571 -5	.7153 -4	.2197 -1	14.89	.2449 -3	3659	2.4224355	111.41	3.843	.3823	259.5	5.868	44.23	.4511 -3	.3483 -2
14.94	.1557 -5	.7106 -4	.2191 -1	14.91	.2433 -3	3683	2.4225066	111.43	3.838	.3823	260.2	5.869	44.35	.4481 -3	.3474 -2
14.96	.1543 -5	.7059 -4	.2185 -1	14.93	.2417 -3	3707	2.4225776	111.46	3.833	.3823	260.9	5.869	44.46	.4452 -3	.3465 -2
14.98	.1529 -5	.7014 -4	.2180 -1	14.95	.2401 -3	3731	2.4226482	111.48	3.828	.3823	261.6	5.869	44.58	.4424 -3	.3456 -2
15.00	.1515 -5	.6968 -4	.2174 -1	14.97	.2386 -3	3755	2.4227186	111.51	3.823	.3823	262.3	5.870	44.69	.4395 -3	.3446 -2
15.02	.1501 -5	.6923 -4	.2168 -1	14.99	.2371 -3	3779	2.4227886	111.53	3.817	.3823	263.0	5.870	44.81	.4367 -3	.3437 -2
15.04	.1487 -5	.6878 -4	.2163 -1	15.01	.2355 -3	3804	2.4228585	111.56	3.812	.3822	263.7	5.870	44.93	.4339 -3	.3428 -2
15.06	.1474 -5	.6833 -4	.2157 -1	15.03	.2340 -3	3829	2.4229280	111.59	3.807	.3822	264.4	5.871	45.05	.4311 -3	.3419 -2
15.08	.1461 -5	.6789 -4	.2151 -1	15.05	.2325 -3	3854	2.4229973	111.61	3.802	.3922	265.1	5.871	45.16	.4283 -3	.3410 -2
15.10	.1447 -5	.6745 -4	.2146 -1	15.07	.2310 -3	3879	2.4230663	111.63	3.797	.3822	265.9	5.871	45.28	.4256 -3	.3401 -2
15.12	.1434 -5	.6702 -4	.2140 -1	15.09	.2296 -3	3904	2.4231350	111.66	3.792	.3822	266.6	5.872	45.40	.4229 -3	.3392 -2
15.14	.1421 -5	.6658 -4	.2135 -1	15.11	.2281 -3	3929	2.4232035	111.68	3.787	.3822	267.3	5.872	45.52	.4201 -3	.3383 -2
15.16	.1409 -5	.6615 -4	.2129 -1	15.13	.2266 -3	3955	2.4232717	111.71	3.782	.3822	268.0	5.872	45.63	.4175 -3	.3374 -2
15.18	.1396 -5	.6573 -4	.2124 -1	15.15	.2252 -3	3980	2.4233396	111.73	3.777	.3822	268.7	5.873	45.75	.4148 -3	.3365 -2
15.20	.1383 -5	.6531 -4	.2118 -1	15.17	.2237 -3	4005	2.4234073	111.76	3.772	.3822	269.4	5.873	45.87	.4122 -3	.3357 -2
15.22	.1371 -5	.6489 -4	.2113 -1	15.19	.2223 -3	4032	2.4234747	111.78	3.767	.3821	270.1	5.873	45.99	.4096 -3	.3347 -2
15.24	.1359 -5	.6447 -4	.2107 -1	15.21	.2209 -3	4057	2.4235419	111.80	3.762	.3821	270.8	5.874	46.11	.4070 -3	.3339 -2
15.26	.1347 -5	.6406 -4	.2102 -1	15.23	.2195 -3	4083	2.4236088	111.83	3.757	.3821	271.5	5.874	46.22	.4044 -3	.3330 -2
15.28	.1335 -5	.6365 -4	.2097 -1	15.25	.2181 -3	4110	2.4236754	111.85	3.752	.3821	272.2	5.874	46.34	.4018 -3	.3321 -2
15.30	.1323 -5	.6325 -4	.2091 -1	15.27	.2167 -3	4135	2.4237418	111.88	3.748	.3821	272.9	5.875	46.46	.3992 -3	.3313 -2
15.32	.1311 -5	.6284 -4	.2086 -1	15.29	.2154 -3	4162	2.4238079	111.90	3.743	.3821	273.7	5.875	46.58	.3967 -3	.3304 -2
15.34	.1299 -5	.6244 -4	.2081 -1	15.31	.2140 -3	4189	2.4238738	111.92	3.738	.3821	274.4	5.875	46.70	.3942 -3	.3295 -2
15.36	.1288 -5	.6204 -4	.2075 -1	15.33	.2127 -3	4215	2.4239394	111.95	3.733	.3821	275.1	5.876	46.82	.3917 -3	.3287 -2
15.38	.1276 -5	.6165 -4	.2070 -1	15.35	.2113 -3	4242	2.4240048	111.97	3.728	.3821	275.8	5.876	46.94	.3893 -3	.3278 -2
15.40	.1265 -5	.6126 -4	.2065 -1	15.37	.2100 -3	4269	2.4240699	112.00	3.723	.3820	276.5	5.876	47.06	.3868 -3	.3270 -2
15.42	.1254 -5	.6087 -4	.2060 -1	15.39	.2087 -3	4296	2.4241348	112.02	3.718	.3820	277.2	5.876	47.18	.3844 -3	.3262 -2
15.44	.1243 -5	.6049 -4	.2054 -1	15.41	.2074 -3	4323	2.4241994	112.04	3.714	.3820	278.0	5.877	47.30	.3820 -3	.3253 -2
15.46	.1232 -5	.6010 -4	.2049 -1	15.43	.2061 -3	4351	2.4242638	112.06	3.709	.3820	278.7	5.877	47.42	.3796 -3	.3245 -2
15.48	.1221 -5	.5972 -4	.2044 -1	15.45	.2048 -3	4378	2.4243280	112.09	3.704	.3820	279.4	5.877	47.54	.3772 -3	.3236 -2
15.50	.1210 -5	.5935 -4	.2039 -1	15.47	.2035 -3	4406	2.4243918	112.11	3.699	.3820	280.1	5.878	47.66	.3748 -3	.3228 -2
15.52	.1199 -5	.5897 -4	.2034 -1	15.49	.2022 -3	4434	2.4244555	112.14	3.694	.3820	280.9	5.878	47.78	.3725 -3	.3220 -2
15.54	.1189 -5	.5861 -4	.2029 -1	15.51	.2010 -3	4462	2.4245189	112.16	3.690	.3820	281.6	5.878	47.90	.3702 -3	.3211 -2
15.56	.1178 -5	.5824 -4	.2023 -1	15.53	.1997 -3	4490	2.4245821	112.18	3.685	.3820	282.3	5.879	48.02	.3679 -3	.3203 -2
15.58	.1168 -5	.5787 -4	.2018 -1	15.55	.1985 -3	4518	2.4246450	112.20	3.680	.3819	283.0	5.879	48.14	.3656 -3	.3195 -2
15.60	.1158 -5	.5751 -4	.2013 -1	15.57	.1972 -3	4546	2.4247077	112.23	3.675	.3819	283.8	5.879	48.26	.3633 -3	.3187 -2
15.62	.1148 -5	.5715 -4	.2008 -1	15.59	.1960 -3	4575	2.4247702	112.25	3.671	.3819	284.5	5.880	48.39	.3610 -3	.3179 -2
15.64	.1138 -5	.5679 -4	.2003 -1	15.61	.1948 -3	4604	2.4248324	112.27	3.666	.3819	285.2	5.880	48.51	.3588 -3	.3170 -2
15.66	.1128 -5	.5643 -4	.1998 -1	15.63	.1936 -3	4633	2.4248944	112.30	3.661	.3819	285.9	5.880	48.63	.3566 -3	.3162 -2
15.68	.1118 -5	.5606 -4	.1993 -1	15.65	.1924 -3	4662	2.4249562	112.32	3.657	.3819	286.7	5.880	48.75	.3544 -3	.3154
15.70	.1108 -5	.5574 -4	.1988 -1	15.67	.1912 -3	4690	2.4250177	112.34	3.652	.3819	287.4	5.881	48.87	.3522 -3	.3147
15.72	.1099 -5	.5539 -4	.1983 -1	15.69	.1900 -3	4720	2.4250790	112.37	3.647	.3819	288.1	5.881	49.00	.3500 -3	.3139
15.74	.1089 -5	.5505 -4	.1978 -1	15.71	.1889 -3	4749	2.4251401	112.39	3.643	.3819	288.9	5.881	49.12	.3479 -3	.3131
15.76	.1079 -5	.5470 -4	.1973 -1	15.73	.1877 -3	4779	2.4252009	112.41	3.638	.3819	289.6	5.882	49.24	.3457 -3	.3122
15.78	.1070 -5	.5436 -4	.1968 -1	15.75	.1865 -3	4809	2.4252616	112.43	3.633	.3818	290.3	5.882	49.36	.3436 -3	.3114 -2
15.80	.1061 -5	.5403 -4	.1964 -1	15.77	.1854 -3	4838	2.4253220	112.45	3.629	.3818	291.1	5.882	49.49	.3415 -3	.3107 -2
15.82	.1052 -5	.5369 -4	.1959 -1	15.79	.1843 -3	4868	2.4253821	112.48	3.624	.3818	291.8	5.883	49.61	.3394 -3	.3099 -2
15.84	.1043 -5	.5336 -4	.1954 -1	15.81	.1831 -3	4899	2.4254421	112.50	3.620	.3818	292.6	5.883	49.73	.3373 -3	.3091 -2
15.86	.1034 -5	.5303 -4	.1949 -1	15.83	.1820 -3	4929	2.4255018	112.52	3.615	.3818	293.3	5.883	49.86	.3352 -3	.3083 -2
15.88	.1025 -5	.5271 -4	.1944 -1	15.85	.1809 -3	4959	2.4255613	112.55	3.610	.3818	294.0	5.883	49.98	.3332 -3	.3076 -2

TABLE II.—SUPERSONIC FLOW—Continued

$\gamma=7/5$

M or M_1	$\frac{p}{p_t}$	$\frac{\rho}{\rho_t}$	$\frac{T}{T_t}$	β	$\frac{q}{p_t}$	$\frac{A}{A_*}$	$\frac{V}{a_*}$	ν	μ	M_2	$\frac{p_2}{p_1}$	$\frac{\rho_2}{\rho_1}$	$\frac{T_2}{T_1}$	$\frac{p_{t_2}}{p_{t_1}}$	$\frac{p_1}{p_{t_2}}$
15.90	.1016 -5	.5238 -4	.1939 -1	15.87	.1798 -3	4990	2.4256206	112.57	3.606	.3818	294.8	5.884	50.10	.3311 -3	.3068 -2
15.92	.1007 -5	.5206 -4	.1935 -1	15.89	.1787 -3	5020	2.4256797	112.59	3.601	.3818	295.5	5.884	50.23	.3291 -3	.3060 -2
15.94	.9986 -6	.5174 -4	.1930 -1	15.91	.1776 -3	5051	2.4257385	112.61	3.597	.3818	296.3	5.884	50.35	.3271 -3	.3053 -2
15.96	.9899 -6	.5142 -4	.1925 -1	15.93	.1765 -3	5082	2.4257971	112.63	3.592	.3818	297.0	5.885	50.47	.3251 -3	.3045 -2
15.98	.9815 -6	.5111 -4	.1920 -1	15.95	.1754 -3	5113	2.4258555	112.66	3.588	.3818	297.8	5.885	50.60	.3232 -3	.3037 -2
16.00	.9731 -6	.5079 -4	.1916 -1	15.97	.1744 -3	5145	2.4259137	112.68	3.583	.3817	298.5	5.885	50.72	.3212 -3	.3030 -2
16.02	.9647 -6	.5048 -4	.1911 -1	15.99	.1733 -3	5176	2.4259717	112.70	3.579	.3817	299.3	5.885	50.85	.3192 -3	.3022 -2
16.04	.9565 -6	.5017 -4	.1906 -1	16.01	.1723 -3	5208	2.4260295	112.72	3.574	.3817	300.0	5.886	50.97	.3173 -3	.3015 -2
16.06	.9484 -6	.4987 -4	.1902 -1	16.03	.1712 -3	5239	2.4260871	112.74	3.570	.3817	300.7	5.886	51.10	.3154 -3	.3007 -2
16.08	.9404 -6	.4957 -4	.1897 -1	16.05	.1702 -3	5271	2.4261444	112.76	3.566	.3817	301.5	5.886	51.22	.3135 -3	.3000 -2
16.10	.9323 -6	.4926 -4	.1892 -1	16.07	.1692 -3	5304	2.4262015	112.79	3.561	.3817	302.3	5.887	51.35	.3116 -3	.2992 -2
16.12	.9244 -6	.4897 -4	.1888 -1	16.09	.1681 -3	5336	2.4262585	112.81	3.557	.3817	303.0	5.887	51.47	.3097 -3	.2985 -2
16.14	.9165 -6	.4867 -4	.1883 -1	16.11	.1671 -3	5369	2.4263152	112.83	3.552	.3817	303.8	5.887	51.60	.3079 -3	.2977 -2
16.16	.9089 -6	.4838 -4	.1879 -1	16.13	.1661 -3	5401	2.4263717	112.85	3.548	.3817	304.5	5.887	51.72	.3060 -3	.2970 -2
16.18	.9011 -6	.4808 -4	.1874 -1	16.15	.1651 -3	5434	2.4264280	112.87	3.543	.3817	305.3	5.888	51.85	.3042 -3	.2963 -2
16.20	.8936 -6	.4779 -4	.1870 -1	16.17	.1642 -3	5466	2.4264841	112.89	3.539	.3817	306.0	5.888	51.97	.3024 -3	.2955 -2
16.22	.8860 -6	.4751 -4	.1865 -1	16.19	.1632 -3	5499	2.4265400	112.91	3.535	.3816	306.8	5.888	52.10	.3005 -3	.2948 -2
16.24	.8784 -6	.4721 -4	.1861 -1	16.21	.1622 -3	5533	2.4265958	112.94	3.530	.3816	307.5	5.888	52.23	.2987 -3	.2941 -2
16.26	.8712 -6	.4694 -4	.1856 -1	16.23	.1612 -3	5566	2.4266513	112.96	3.526	.3816	308.3	5.889	52.35	.2969 -3	.2934 -2
16.28	.8638 -6	.4665 -4	.1852 -1	16.25	.1603 -3	5600	2.4267066	112.98	3.522	.3816	309.0	5.889	52.48	.2952 -3	.2926 -2
16.30	.8565 -6	.4637 -4	.1847 -1	16.27	.1593 -3	5634	2.4267617	113.00	3.517	.3816	309.8	5.889	52.61	.2934 -3	.2919 -2
16.32	.8491 -6	.4609 -4	.1843 -1	16.29	.1584 -3	5667	2.4268166	113.02	3.513	.3816	310.6	5.889	52.73	.2916 -3	.2912 -2
16.34	.8423 -6	.4582 -4	.1838 -1	16.31	.1574 -3	5701	2.4268713	113.04	3.509	.3816	311.3	5.890	52.86	.2899 -3	.2905 -2
16.36	.8352 -6	.4554 -4	.1834 -1	16.33	.1565 -3	5735	2.4269258	113.06	3.504	.3816	312.1	5.890	52.99	.2882 -3	.2898 -2
16.38	.8283 -6	.4527 -4	.1830 -1	16.35	.1556 -3	5770	2.4269801	113.08	3.500	.3816	312.9	5.890	53.12	.2865 -3	.2891 -2
16.40	.8213 -6	.4500 -4	.1825 -1	16.37	.1546 -3	5804	2.4270342	113.11	3.496	.3816	313.6	5.891	53.24	.2848 -3	.2884 -2
16.42	.8144 -6	.4473 -4	.1821 -1	16.39	.1537 -3	5839	2.4270881	113.13	3.492	.3816	314.4	5.891	53.37	.2831 -3	.2877 -2
16.44	.8077 -6	.4447 -4	.1816 -1	16.41	.1528 -3	5874	2.4271418	113.15	3.487	.3815	315.2	5.891	53.50	.2814 -3	.2870 -2
16.46	.8009 -6	.4420 -4	.1812 -1	16.43	.1519 -3	5910	2.4271954	113.17	3.483	.3815	315.9	5.891	53.63	.2798 -3	.2863 -2
16.48	.7942 -6	.4394 -4	.1808 -1	16.45	.1510 -3	5945	2.4272487	113.19	3.479	.3815	316.7	5.892	53.75	.2781 -3	.2856 -2
16.50	.7876 -6	.4367 -4	.1803 -1	16.47	.1501 -3	5980	2.4273019	113.21	3.475	.3815	317.5	5.892	53.88	.2765 -3	.2849 -2
16.52	.7811 -6	.4341 -4	.1799 -1	16.49	.1492 -3	6016	2.4273548	113.23	3.470	.3815	318.2	5.892	54.01	.2749 -3	.2842 -2
16.54	.7747 -6	.4316 -4	.1795 -1	16.51	.1484 -3	6051	2.4274076	113.25	3.466	.3815	319.0	5.892	54.14	.2732 -3	.2836 -2
16.56	.7682 -6	.4290 -4	.1791 -1	16.53	.1475 -3	6087	2.4274602	113.27	3.462	.3815	319.8	5.893	54.27	.2716 -3	.2828 -2
16.58	.7620 -6	.4265 -4	.1786 -1	16.55	.1466 -3	6123	2.4275126	113.29	3.458	.3815	320.6	5.893	54.40	.2700 -3	.2822 -2
16.60	.7556 -6	.4240 -4	.1782 -1	16.57	.1457 -3	6160	2.4275648	113.31	3.454	.3815	321.3	5.893	54.53	.2685 -3	.2814 -2
16.62	.7493 -6	.4215 -4	.1778 -1	16.59	.1449 -3	6196	2.4276169	113.33	3.449	.3815	322.1	5.893	54.66	.2669 -3	.2808 -2
16.64	.7432 -6	.4190 -4	.1774 -1	16.61	.1440 -3	6233	2.4276687	113.35	3.445	.3815	322.9	5.894	54.78	.2653 -3	.2801 -2
16.66	.7372 -6	.4166 -4	.1770 -1	16.63	.1432 -3	6268	2.4277204	113.37	3.441	.3815	323.7	5.894	54.91	.2638 -3	.2795 -2
16.68	.7311 -6	.4141 -4	.1765 -1	16.65	.1424 -3	6306	2.4277719	113.39	3.437	.3814	324.4	5.894	55.04	.2622 -3	.2788 -2
16.70	.7250 -6	.4117 -4	.1761 -1	16.67	.1415 -3	6343	2.4278232	113.41	3.433	.3814	325.2	5.894	55.17	.2607 -3	.2781 -2
16.72	.7191 -6	.4093 -4	.1757 -1	16.69	.1407 -3	6380	2.4278743	113.43	3.429	.3814	326.0	5.895	55.30	.2592 -3	.2774 -2
16.74	.7132 -6	.4069 -4	.1753 -1	16.71	.1399 -3	6417	2.4279252	113.45	3.425	.3814	326.8	5.895	55.43	.2577 -3	.2768 -2
16.76	.7074 -6	.4045 -4	.1749 -1	16.73	.1391 -3	6455	2.4279760	113.47	3.421	.3814	327.6	5.895	55.56	.2562 -3	.2762 -2
16.78	.7016 -6	.4021 -4	.1745 -1	16.75	.1383 -3	6493	2.4280266	113.49	3.417	.3814	328.3	5.895	55.69	.2547 -3	.2755 -2
16.80	.6959 -6	.3998 -4	.1741 -1	16.77	.1375 -3	6531	2.4280770	113.51	3.413	.3814	329.1	5.896	55.82	.2532 -3	.2748 -2
16.82	.6902 -6	.3974 -4	.1737 -1	16.79	.1367 -3	6570	2.4281272	113.53	3.408	.3814	329.9	5.896	55.96	.2517 -3	.2742 -2
16.84	.6846 -6	.3951 -4	.1733 -1	16.81	.1359 -3	6607	2.4281772	113.55	3.404	.3814	330.7	5.896	56.09	.2503 -3	.2735 -2
16.86	.6790 -6	.3928 -4	.1729 -1	16.83	.1351 -3	6647	2.4282271	113.57	3.400	.3814	331.5	5.896	56.22	.2488 -3	.2729 -2
16.88	.6735 -6	.3905 -4	.1725 -1	16.85	.1343 -3	6685	2.4282768	113.59	3.396	.3814	332.3	5.897	56.35	.2474 -3	.2722 -2
16.90	.6680 -6	.3883 -4	.1721 -1	16.87	.1336 -3	6724	2.4283264	113.61	3.392	.3814	333.1	5.897	56.48	.2460 -3	.2716 -2
16.92	.6626 -6	.3860 -4	.1717 -1	16.89	.1328 -3	6763	2.4283757	113.63	3.388	.3813	333.8	5.897	56.61	.2446 -3	.2709 -2
16.94	.6572 -6	.3838 -4	.1713 -1	16.91	.1320 -3	6802	2.4284249	113.65	3.384	.3813	334.6	5.897	56.74	.2432 -3	.2703 -2
16.96	.6520 -6	.3816 -4	.1709 -1	16.93	.1313 -3	6841	2.4284739	113.67	3.380	.3813	335.4	5.898	56.88	.2418 -3	.2697 -2
16.98	.6467 -6	.3794 -4	.1705 -1	16.95	.1305 -3	6881	2.4285228	113.69	3.376	.3813	336.2	5.898	57.01	.2404 -3	.2690 -2
17.00	.6415 -6	.3772 -4	.1701 -1	16.97	.1298 -3	6920	2.4285714	113.71	3.372	.3813	337.0	5.898	57.14	.2390 -3	.2684 -2
17.02	.6364 -6	.3750 -4	.1697 -1	16.99	.1290 -3	6960	2.4286199	113.73	3.368	.3813	337.8	5.898	57.27	.2376 -3	.2678 -2
17.04	.6311 -6	.3728 -4	.1693 -1	17.01	.1283 -3	7001	2.4286683	113.75	3.364	.3813	338.6	5.898	57.40	.2363 -3	.2671 -2
17.06	.6261 -6	.3707 -4	.1689 -1	17.03	.1276 -3	7042	2.4287164	113.77	3.360	.3813	339.4	5.899	57.54	.2349 -3	.2665 -2
17.08	.6211 -6	.3686 -4	.1685 -1	17.05	.1268 -3	7081	2.4287645	113.79	3.356	.3813	340.2	5.899	57.67	.2336 -3	.2659 -2
17.10	.6161 -6	.3665 -4	.1681 -1	17.07	.1261 -3	7122	2.4288123	113.81	3.353	.3813	341.0	5.899	57.80	.2322 -3	.2653 -2
17.12	.6111 -6	.3644 -4	.1677 -1	17.09	.1254 -3	7163	2.4288600	113.83	3.349	.3813	341.8	5.899	57.94	.2309 -3	.2646 -2
17.14	.6063 -6	.3623 -4	.1674 -1	17.11	.1247 -3	7204	2.4289075	113.85	3.345	.3813	342.6	5.900	58.07	.2296 -3	.2641 -2
17.16	.6014 -6	.3602 -4	.1670 -1	17.13	.1240 -3	7246	2.4289548	113.87	3.341	.3813	343.4	5.900	58.20	.2283 -3	.2634 -2
17.18	.5966 -6	.3581 -4	.1666 -1	17.15	.1233 -3	7287	2.4290020	113.88	3.337	.3812	344.2	5.900	58.34	.2270 -3	.2628 -2
17.20	.5918 -6	.3561 -4	.1662 -1	17.17	.1226 -3	7329	2.4290490	113.90	3.333	.3812	345.0	5.900	58.47	.2257 -3	.2622 -2
17.22	.5871 -6	.3541 -4	.1658 -1	17.19	.1219 -3	7371	2.4290959	113.92	3.329	.3812	345.8	5.901	58.60	.2245 -3	.2616 -2
17.24	.5824 -6	.3520 -4	.1654 -1	17.21	.1212 -3	7413	2.4291426	113.94	3.325	.3812	346.6	5.901	58.74	.2232 -3	.2610 -2
17.26	.5779 -6	.3501 -4	.1651 -1	17.23	.1205 -3	7454	2.4291891	113.96	3.321	.3812	347.4	5.901	58.87	.2219 -3	.2604 -2
17.28	.5732 -6	.3481 -4	.1647 -1	17.25	.1198 -3	7497	2.4292355	113.98	3.318	.3812	348.2	5.901	59.01	.2207 -3	.2598 -2
17.30	.5687 -6	.3461 -4	.1643 -1	17.27	.1192 -3	7539	2.4292818	114.00	3.314	.3812	349.0	5.901	59.14	.2194 -3	.2592 -2
17.32	.5642 -6	.3441 -4	.1639 -1	17.29	.1185 -3	7583	2.4293278	114.01	3.310	.3812	349.8	5.902	59.27	.2182 -3	.2586 -2
17.34	.5597 -6	.3422 -4	.1636 -1	17.31	.1178 -3	7626	2.4293737	114.03	3.306	.3812	350.6	5.902	59.41	.2170 -3	.2580 -2
17.36	.5553 -6	.3403 -4	.1632 -1	17.33	.1171 -3	7669	2.4294195	114.05	3.302	.3812	351.4	5.902	59.54	.2157 -3	.2574 -2
17.38	.5509 -6	.3383 -4	.1628 -1	17.35	.1165 -3	7713	2.4294651	114.07	3.299	.3812	352.2	5.902	59.68	.2145 -3	.2568 -2
17.40	.5465 -6	.3364 -4	.1625 -1	17.37	.1158 -3	7757	2.4295105	114.09	3.295	.3812	353.1	5.903	59.81	.2133 -3	.2562 -2
17.42	.5423 -6	.3346 -4	.1621 -1	17.39	.1152 -3	7799	2.4295558	114.11	3.291	.3812	353.9	5.903	59.95	.2121 -3	.2557 -2
17.44	.5380 -6	.3326 -4	.1617 -1	17.41	.1145 -3	7844	2.4296010	114.13	3.287	.3811	354.7	5.903	60.09	.2109 -3	.2550 -2
17.46	.5338 -6	.3308 -4	.1614 -1	17.43	.1139 -3	7888	2.4296460	114.15	3.283	.3811	355.5	5.903	60.22	.2098 -3	.2545 -2
17.48	.5295 -6	.3289 -4	.1610 -1	17.45	.1133 -3	7933	2.4296908	114.16	3.280	.3811	356.3	5.903	60.36	.2086 -3	.2539 -2
17.50	.5254 -6	.3271 -4	.1606 -1	17.47	.1126 -3	7977	2.4297355	114.18	3.276	.3811	357.1	5.904	60.49	.2074 -3	.2533 -2
17.52	.5213 -6	.3252 -4	.1603 -1	17.49	.1120 -3	8022	2.4297800	114.20	3.272	.3811	357.9	5.904	60.63	.2063 -3	.2527 -2
17.54	.5172 -6	.3234 -4	.1599 -1	17.51	.1114 -3	8067	2.4298244	114.22	3.268	.3811	358.8	5.904	60.77	.2051 -3	.2522 -2
17.56	.5131 -6	.3216 -4	.1596 -1	17.53	.1108 -3	8113	2.4298686	114.24	3.265	.3811	359.6	5.904	60.90	.2040 -3	.2516 -2
17.58	.5092 -6	.3198 -4	.1592 -1	17.55	.1102 -3	8157	2.4299127	114.26	3.261	.3811	360.4	5.905	61.04	.2029 -3	.2510 -2
17.60	.5052 -6	.3180 -4	.1589 -1	17.57	.1095 -3	8203	2.4299566	114.27	3.257	.3811	361.2	5.905	61.18	.2017 -3	.2504 -2
17.62	.5013 -6	.3163 -4	.1585 -1	17.59	.1090 -3	8248	2.4300004	114.29	3.254	.3811	362.0	5.905	61.31	.2006 -3	.2499 -2
17.64	.4973 -6	.3145 -4	.1581 -1	17.61	.1083 -3	8295	2.4300441	114.31	3.250	.3811	362.9	5.905	61.45	.1995 -3	.2493 -2
17.66	.4935 -6	.3128 -4	.1578 -1	17.63	.1077 -3	8341	2.4300876	114.33	3.246	.3811	363.7	5.905	61.59	.1984 -3	.2488 -2
17.68	.4897 -6	.3110 -4	.1574 -1	17.65	.1071 -3	8387	2.4301309	114.35	3.242	.3811	364.5	5.906	61.72	.1973 -3	.2482 -2

TABLE II.—SUPERSONIC FLOW—Continued

$\gamma=7/5$

M or M_1	$\frac{p}{p_t}$	$\frac{\rho}{\rho_t}$	$\frac{T}{T_t}$	β	$\frac{q}{p_t}$	$\frac{A}{A_*}$	$\frac{V}{a_*}$	ν	μ	M_2	$\frac{p_2}{p_1}$	$\frac{\rho_2}{\rho_1}$	$\frac{T_2}{T_1}$	$\frac{p_{t_2}}{p_{t_1}}$	$\frac{p_1}{p_{t_2}}$
17.70	.4859 -6	.3093 -4	.1571 -1	17.67	.1066 -3	8434	2.4301741	114.36	3.239	.3811	365.3	5.906	61.86	.1962 -3	.2476 -2
17.72	.4821 -6	.3076 -4	.1567 -1	17.69	.1060 -3	8481	2.4302172	114.38	3.235	.3810	366.2	5.906	62.00	.1951 -3	.2471 -2
17.74	.4783 -6	.3059 -4	.1564 -1	17.71	.1054 -3	8529	2.4302601	114.40	3.231	.3810	367.0	5.906	62.14	.1941 -3	.2465 -2
17.76	.4747 -6	.3042 -4	.1561 -1	17.73	.1048 -3	8575	2.4303029	114.42	3.228	.3810	367.8	5.906	62.28	.1930 -3	.2460 -2
17.78	.4710 -6	.3025 -4	.1557 -1	17.75	.1042 -3	8623	2.4303455	114.44	3.224	.3810	368.7	5.907	62.41	.1919 -3	.2454 -2
17.80	.4674 -6	.3009 -4	.1554 -1	17.77	.1037 -3	8670	2.4303880	114.45	3.221	.3810	369.5	5.907	62.55	.1909 -3	.2449 -2
17.82	.4637 -6	.2992 -4	.1550 -1	17.79	.1031 -3	8719	2.4304304	114.47	3.217	.3810	370.3	5.907	62.69	.1898 -3	.2443 -2
17.84	.4602 -6	.2975 -4	.1547 -1	17.81	.1025 -3	8767	2.4304726	114.49	3.213	.3810	371.1	5.907	62.83	.1888 -3	.2437 -2
17.86	.4566 -6	.2959 -4	.1543 -1	17.83	.1020 -3	8815	2.4305147	114.51	3.210	.3810	372.0	5.907	62.97	.1878 -3	.2432 -2
17.88	.4531 -6	.2943 -4	.1540 -1	17.85	.1014 -3	8864	2.4305566	114.52	3.206	.3810	372.8	5.908	63.11	.1867 -3	.2427 -2
17.90	.4496 -6	.2926 -4	.1537 -1	17.87	.1009 -3	8913	2.4305984	114.54	3.203	.3810	373.7	5.908	63.25	.1857 -3	.2421 -2
17.92	.4462 -6	.2910 -4	.1533 -1	17.89	.1003 -3	8962	2.4306401	114.56	3.199	.3810	374.5	5.908	63.39	.1847 -3	.2416 -2
17.94	.4428 -6	.2895 -4	.1530 -1	17.91	.9976 -4	9010	2.4306816	114.58	3.195	.3810	375.3	5.908	63.53	.1837 -3	.2411 -2
17.96	.4394 -6	.2879 -4	.1526 -1	17.93	.9921 -4	9060	2.4307230	114.59	3.192	.3810	376.2	5.908	63.67	.1827 -3	.2405 -2
17.98	.4361 -6	.2863 -4	.1523 -1	17.95	.9868 -4	9109	2.4307642	114.61	3.188	.3810	377.0	5.909	63.80	.1817 -3	.2400 -2
18.00	.4328 -6	.2848 -4	.1520 -1	17.97	.9815 -4	9159	2.4308053	114.63	3.185	.3810	377.8	5.909	63.94	.1807 -3	.2395 -2
18.02	.4294 -6	.2832 -4	.1516 -1	17.99	.9760 -4	9210	2.4308463	114.65	3.181	.3809	378.7	5.909	64.08	.1797 -3	.2389 -2
18.04	.4261 -6	.2816 -4	.1513 -1	18.01	.9707 -4	9260	2.4308872	114.66	3.178	.3809	379.5	5.909	64.23	.1788 -3	.2384 -2
18.06	.4229 -6	.2801 -4	.1510 -1	18.03	.9655 -4	9311	2.4309279	114.68	3.174	.3809	380.4	5.909	64.37	.1778 -3	.2379 -2
18.08	.4197 -6	.2786 -4	.1507 -1	18.05	.9602 -4	9362	2.4309685	114.70	3.171	.3809	381.2	5.910	64.51	.1768 -3	.2373 -2
18.10	.4165 -6	.2771 -4	.1503 -1	18.07	.9552 -4	9411	2.4310089	114.72	3.167	.3809	382.1	5.910	64.65	.1759 -3	.2368 -2
18.12	.4134 -6	.2756 -4	.1500 -1	18.09	.9500 -4	9463	2.4310492	114.73	3.164	.3809	382.9	5.910	64.79	.1749 -3	.2363 -2
18.14	.4102 -6	.2741 -4	.1497 -1	18.11	.9448 -4	9515	2.4310894	114.75	3.160	.3809	383.7	5.910	64.93	.1740 -3	.2357 -2
18.16	.4071 -6	.2726 -4	.1494 -1	18.13	.9398 -4	9566	2.4311295	114.77	3.157	.3809	384.6	5.910	65.07	.1731 -3	.2353 -2
18.18	.4041 -6	.2711 -4	.1490 -1	18.15	.9349 -4	9617	2.4311694	114.78	3.153	.3809	385.4	5.911	65.21	.1721 -3	.2348 -2
18.20	.4010 -6	.2696 -4	.1487 -1	18.17	.9297 -4	9671	2.4312092	114.80	3.150	.3809	386.3	5.911	65.35	.1712 -3	.2342 -2
18.22	.3979 -6	.2682 -4	.1484 -1	18.19	.9247 -4	9723	2.4312488	114.82	3.146	.3809	387.1	5.911	65.49	.1703 -3	.2337 -2
18.24	.3949 -6	.2667 -4	.1481 -1	18.21	.9198 -4	9775	2.4312884	114.83	3.143	.3809	388.0	5.911	65.64	.1694 -3	.2332 -2
18.26	.3920 -6	.2653 -4	.1477 -1	18.23	.9148 -4	9828	2.4313278	114.85	3.139	.3809	388.8	5.911	65.78	.1685 -3	.2327 -2
18.28	.3890 -6	.2639 -4	.1474 -1	18.25	.9099 -4	9881	2.4313671	114.87	3.136	.3809	389.7	5.912	65.92	.1676 -3	.2321 -2
18.30	.3861 -6	.2625 -4	.1471 -1	18.27	.9052 -4	9933	2.4314062	114.89	3.133	.3809	390.5	5.912	66.06	.1667 -3	.2317 -2
18.32	.3832 -6	.2611 -4	.1468 -1	18.29	.9003 -4	9987	2.4314452	114.90	3.129	.3809	391.4	5.912	66.20	.1658 -3	.2312 -2
18.34	.3803 -6	.2596 -4	.1465 -1	18.31	.8954 -4	1004 +1	2.4314841	114.92	3.126	.3808	392.3	5.912	66.35	.1649 -3	.2306 -2
18.36	.3775 -6	.2583 -4	.1462 -1	18.33	.8907 -4	1010 +1	2.4315229	114.94	3.122	.3808	393.1	5.912	66.49	.1640 -3	.2302 -2
18.38	.3747 -6	.2569 -4	.1459 -1	18.35	.8861 -4	1015 +1	2.4315616	114.95	3.119	.3808	394.0	5.913	66.63	.1632 -3	.2297 -2
18.40	.3718 -6	.2555 -4	.1455 -1	18.37	.8812 -4	1020 +1	2.4316001	114.97	3.115	.3808	394.8	5.913	66.78	.1623 -3	.2291 -2
18.42	.3691 -6	.2541 -4	.1452 -1	18.39	.8765 -4	1026 +1	2.4316385	114.99	3.112	.3808	395.7	5.913	66.92	.1614 -3	.2287 -2
18.44	.3663 -6	.2528 -4	.1449 -1	18.41	.8719 -4	1031 +1	2.4316768	115.00	3.109	.3808	396.5	5.913	67.06	.1606 -3	.2281 -2
18.46	.3636 -6	.2514 -4	.1446 -1	18.43	.8673 -4	1037 +1	2.4317149	115.02	3.105	.3808	397.4	5.913	67.21	.1597 -3	.2277 -2
18.48	.3609 -6	.2501 -4	.1443 -1	18.45	.8628 -4	1042 +1	2.4317530	115.04	3.102	.3808	398.3	5.913	67.35	.1589 -3	.2272 -2
18.50	.3582 -6	.2488 -4	.1440 -1	18.47	.8582 -4	1048 +1	2.4317909	115.05	3.099	.3808	399.1	5.914	67.49	.1580 -3	.2267 -2
18.52	.3555 -6	.2475 -4	.1437 -1	18.49	.8536 -4	1054 +1	2.4318287	115.07	3.095	.3808	400.0	5.914	67.64	.1572 -3	.2262 -2
18.54	.3530 -6	.2462 -4	.1434 -1	18.51	.8492 -4	1059 +1	2.4318664	115.08	3.092	.3808	400.9	5.914	67.78	.1564 -3	.2257 -2
18.56	.3503 -6	.2448 -4	.1431 -1	18.53	.8446 -4	1065 +1	2.4319039	115.10	3.089	.3808	401.7	5.914	67.93	.1555 -3	.2252 -2
18.58	.3477 -6	.2436 -4	.1428 -1	18.55	.8403 -4	1070 +1	2.4319413	115.12	3.085	.3808	402.6	5.914	68.07	.1547 -3	.2248 -2
18.60	.3452 -6	.2423 -4	.1425 -1	18.57	.8359 -4	1076 +1	2.4319787	115.13	3.082	.3808	403.5	5.915	68.21	.1539 -3	.2243 -2
18.62	.3426 -6	.2410 -4	.1422 -1	18.59	.8315 -4	1082 +1	2.4320159	115.15	3.079	.3808	404.3	5.915	68.36	.1531 -3	.2238 -2
18.64	.3400 -6	.2397 -4	.1419 -1	18.61	.8270 -4	1088 +1	2.4320529	115.17	3.075	.3808	405.2	5.915	68.50	.1523 -3	.2233 -2
18.66	.3375 -6	.2384 -4	.1416 -1	18.63	.8226 -4	1093 +1	2.4320899	115.18	3.072	.3807	406.1	5.915	68.65	.1515 -3	.2228 -2
18.68	.3351 -6	.2372 -4	.1413 -1	18.65	.8185 -4	1099 +1	2.4321267	115.20	3.069	.3807	406.9	5.915	68.79	.1507 -3	.2224 -2
18.70	.3326 -6	.2359 -4	.1410 -1	18.67	.8142 -4	1105 +1	2.4321635	115.21	3.065	.3807	407.8	5.915	68.94	.1499 -3	.2219 -2
18.72	.3301 -6	.2347 -4	.1407 -1	18.69	.8099 -4	1111 +1	2.4322001	115.23	3.062	.3807	408.7	5.916	69.09	.1491 -3	.2214 -2
18.74	.3278 -6	.2335 -4	.1404 -1	18.71	.8058 -4	1116 +1	2.4322366	115.25	3.059	.3807	409.6	5.916	69.23	.1484 -3	.2209 -2
18.76	.3253 -6	.2322 -4	.1401 -1	18.73	.8015 -4	1122 +1	2.4322729	115.26	3.056	.3807	410.4	5.916	69.38	.1476 -3	.2205 -2
18.78	.3230 -6	.2310 -4	.1398 -1	18.75	.7974 -4	1128 +1	2.4323092	115.28	3.052	.3807	411.3	5.916	69.52	.1468 -3	.2200 -2
18.80	.3206 -6	.2298 -4	.1395 -1	18.77	.7931 -4	1134 +1	2.4323454	115.29	3.049	.3807	412.2	5.916	69.67	.1460 -3	.2195 -2
18.82	.3182 -6	.2286 -4	.1392 -1	18.79	.7890 -4	1140 +1	2.4323814	115.31	3.046	.3807	413.1	5.917	69.82	.1453 -3	.2191 -2
18.84	.3159 -6	.2274 -4	.1389 -1	18.81	.7849 -4	1146 +1	2.4324173	115.33	3.043	.3807	413.9	5.917	69.96	.1445 -3	.2186 -2
18.86	.3136 -6	.2262 -4	.1386 -1	18.83	.7809 -4	1152 +1	2.4324531	115.34	3.039	.3807	414.8	5.917	70.11	.1438 -3	.2182 -2
18.88	.3113 -6	.2251 -4	.1383 -1	18.85	.7768 -4	1158 +1	2.4324888	115.36	3.036	.3807	415.7	5.917	70.26	.1430 -3	.2177 -2
18.90	.3090 -6	.2239 -4	.1380 -1	18.87	.7727 -4	1164 +1	2.4325244	115.38	3.033	.3807	416.6	5.917	70.40	.1423 -3	.2172 -2
18.92	.3068 -6	.2227 -4	.1378 -1	18.89	.7687 -4	1170 +1	2.4325599	115.39	3.030	.3807	417.5	5.917	70.55	.1416 -3	.2167 -2
18.94	.3046 -6	.2216 -4	.1375 -1	18.91	.7649 -4	1176 +1	2.4325953	115.41	3.027	.3807	418.3	5.918	70.70	.1408 -3	.2163 -2
18.96	.3024 -6	.2204 -4	.1372 -1	18.93	.7608 -4	1182 +1	2.4326305	115.42	3.023	.3807	419.2	5.918	70.84	.1401 -3	.2158 -2
18.98	.3002 -6	.2193 -4	.1369 -1	18.95	.7570 -4	1188 +1	2.4326657	115.44	3.020	.3807	420.1	5.918	70.99	.1394 -3	.2154 -2
19.00	.2980 -6	.2181 -4	.1366 -1	18.97	.7530 -4	1195 +1	2.4327007	115.45	3.017	.3806	421.0	5.918	71.14	.1387 -3	.2149 -2
19.02	.2959 -6	.2170 -4	.1363 -1	18.99	.7492 -4	1201 +1	2.4327356	115.47	3.014	.3806	421.9	5.918	71.29	.1379 -3	.2145 -2
19.04	.2937 -6	.2159 -4	.1361 -1	19.01	.7454 -4	1207 +1	2.4327705	115.48	3.011	.3806	422.8	5.918	71.44	.1372 -3	.2141 -2
19.06	.2915 -6	.2148 -4	.1358 -1	19.03	.7414 -4	1213 +1	2.4328052	115.50	3.008	.3806	423.7	5.919	71.58	.1365 -3	.2136 -2
19.08	.2894 -6	.2136 -4	.1355 -1	19.05	.7376 -4	1220 +1	2.4328398	115.52	3.004	.3806	424.6	5.919	71.73	.1358 -3	.2131 -2
19.10	.2874 -6	.2125 -4	.1352 -1	19.07	.7338 -4	1226 +1	2.4328743	115.53	3.001	.3806	425.5	5.919	71.88	.1351 -3	.2127 -2
19.12	.2854 -6	.2115 -4	.1349 -1	19.09	.7302 -4	1232 +1	2.4329087	115.55	2.998	.3806	426.3	5.919	72.03	.1344 -3	.2123 -2
19.14	.2833 -6	.2104 -4	.1347 -1	19.11	.7264 -4	1239 +1	2.4329430	115.56	2.995	.3806	427.2	5.919	72.18	.1337 -3	.2118 -2
19.16	.2812 -6	.2093 -4	.1344 -1	19.13	.7227 -4	1245 +1	2.4329771	115.58	2.992	.3806	428.1	5.919	72.33	.1331 -3	.2114 -2
19.18	.2792 -6	.2082 -4	.1341 -1	19.15	.7189 -4	1252 +1	2.4330112	115.59	2.989	.3806	429.0	5.920	72.48	.1324 -3	.2109 -2
19.20	.2772 -6	.2072 -4	.1338 -1	19.17	.7154 -4	1258 +1	2.4330452	115.61	2.986	.3806	429.9	5.920	72.62	.1317 -3	.2105 -2
19.22	.2752 -6	.2061 -4	.1335 -1	19.19	.7116 -4	1264 +1	2.4330790	115.62	2.982	.3806	430.8	5.920	72.77	.1310 -3	.2100 -2
19.24	.2733 -6	.2050 -4	.1333 -1	19.21	.7081 -4	1271 +1	2.4331128	115.64	2.979	.3806	431.7	5.920	72.92	.1304 -3	.2096 -2
19.26	.2713 -6	.2040 -4	.1330 -1	19.23	.7045 -4	1277 +1	2.4331464	115.65	2.976	.3806	432.6	5.920	73.07	.1297 -3	.2092 -2
19.28	.2694 -6	.2030 -4	.1327 -1	19.25	.7010 -4	1284 +1	2.4331800	115.67	2.973	.3806	433.5	5.920	73.22	.1291 -3	.2088 -2
19.30	.2674 -6	.2019 -4	.1325 -1	19.27	.6973 -4	1291 +1	2.4332135	115.68	2.970	.3806	434.4	5.921	73.37	.1284 -3	.2083 -2
19.32	.2655 -6	.2009 -4	.1322 -1	19.29	.6937 -4	1297 +1	2.4332468	115.70	2.967	.3806	435.3	5.921	73.52	.1277 -3	.2079 -2
19.34	.2636 -6	.1999 -4	.1319 -1	19.31	.6902 -4	1304 +1	2.4332800	115.71	2.964	.3806	436.2	5.921	73.67	.1271 -3	.2074 -2
19.36	.2617 -6	.1988 -4	.1316 -1	19.33	.6867 -4	1310 +1	2.4333132	115.73	2.961	.3805	437.1	5.921	73.82	.1265 -3	.2070 -2
19.38	.2599 -6	.1979 -4	.1314 -1	19.35	.6834 -4	1317 +1	2.4333462	115.74	2.958	.3805	438.0	5.921	73.96	.1258 -3	.2066 -2
19.40	.2581 -6	.1968 -4	.1311 -1	19.37	.6799 -4	1324 +1	2.4333792	115.76	2.955	.3805	438.9	5.921	74.13	.1252 -3	.2062 -2
19.42	.2562 -6	.1958 -4	.1308 -1	19.39	.6764 -4	1330 +1	2.4334120	115.78	2.952	.3805	439.8	5.922	74.28	.1245 -3	.2057 -2
19.44	.2544 -6	.1949 -4	.1306 -1	19.41	.6731 -4	1337 +1	2.4334447	115.79	2.949	.3805	440.7	5.922	74.43	.1239 -3	.2053 -2
19.46	.2526 -6	.1938 -4	.1303 -1	19.43	.6696 -4	1344 +1	2.4334774	115.80	2.946	.3805	441.6	5.922	74.58	.1233 -3	.2049 -2
19.48	.2508 -6	.1929 -4	.1301 -1	19.45	.6663 -4	1351 +1	2.4335099	115.82	2.943	.3805	442.6	5.922	74.73	.1227 -3	.2045 -2

TABLE II.—SUPERSONIC FLOW—Continued

$\gamma = 7/5$

M or M_1	$\frac{p}{p_t}$	$\frac{\rho}{\rho_t}$	$\frac{T}{T_t}$	β	$\frac{q}{p_t}$	$\frac{A}{A_*}$	$\frac{V}{a_*}$	ν	μ	M_2	$\frac{p_2}{p_1}$	$\frac{\rho_2}{\rho_1}$	$\frac{T_2}{T_1}$	$\frac{p_{t_2}}{p_{t_1}}$	$\frac{p_1}{p_{t_2}}$
19.50	.2491 -6	.1919 -4	.1298 -1	19.47	.6630 -4	1357 +1	2.4335424	115.83	2.940	.3805	443.5	5.922	74.88	.1221 -3	.2041 -2
19.52	.2473 -6	.1909 -4	.1295 -1	19.49	.6595 -4	1365 +1	2.4335747	115.85	2.937	.3805	444.4	5.922	75.03	.1214 -3	.2036 -2
19.54	.2455 -6	.1900 -4	.1293 -1	19.51	.6563 -4	1371 +1	2.4336070	115.86	2.934	.3805	445.3	5.922	75.19	.1208 -3	.2032 -2
19.56	.2438 -6	.1890 -4	.1290 -1	19.53	.6530 -4	1378 +1	2.4336391	115.98	2.931	.3805	446.2	5.923	75.34	.1202 -3	.2028 -2
19.58	.2421 -6	.1881 -4	.1287 -1	19.55	.6497 -4	1385 +1	2.4336712	115.89	2.928	.3805	447.1	5.923	75.49	.1196 -3	.2024 -2
19.60	.2404 -6	.1871 -4	.1285 -1	19.57	.6464 -4	1392 +1	2.4337031	115.91	2.025	.3805	448.0	5.923	75.64	.1190 -3	.2020 -2
19.62	.2387 -6	.1862 -4	.1282 -1	19.59	.6432 -4	1399 +1	2.4337350	115.92	2.922	.3805	448.9	5.923	75.80	.1184 -3	.2016 -2
19.64	.2371 -6	.1853 -4	.1280 -1	19.61	.6401 -4	1406 +1	2.4337667	115.94	2.919	.3805	449.9	5.923	75.95	.1178 -3	.2012 -2
19.66	.2354 -6	.1843 -4	.1277 -1	19.63	.6369 -4	1413 +1	2.4337984	115.95	2.916	.3805	450.8	5.923	76.10	.1173 -3	.2008 -2
19.68	.2337 -6	.1834 -4	.1275 -1	19.65	.6336 -4	1420 +1	2.4338300	115.97	2.913	.3805	451.7	5.924	76.25	.1167 -3	.2003 -2
19.70	.2321 -6	.1825 -4	.1272 -1	19.67	.6306 -4	1427 +1	2.4338615	115.98	2.910	.3805	452.6	5.924	76.41	.1161 -3	.2000 -2
19.72	.2305 -6	.1816 -4	.1269 -1	19.69	.6274 -4	1435 +1	2.4338928	116.00	2.907	.3805	453.5	5.924	76.56	.1155 -3	.1995 -2
19.74	.2289 -6	.1807 -4	.1267 -1	19.72	.6243 -4	1442 +1	2.4339241	116.01	2.904	.3805	454.5	5.924	76.71	.1149 -3	.1991 -2
19.76	.2273 -6	.1798 -4	.1264 -1	19.74	.6213 -4	1449 +1	2.4339553	116.03	2.901	.3804	455.4	5.924	76.87	.1144 -3	.1988 -2
19.78	.2257 -6	.1788 -4	.1262 -1	19.76	.6180 -4	1456 +1	2.4339864	116.04	2.898	.3804	456.3	5.924	77.02	.1138 -3	.1983 -2
19.80	.2241 -6	.1780 -4	.1259 -1	19.78	.6150 -4	1464 +1	2.4340174	116.05	2.895	.3804	457.2	5.924	77.17	.1132 -3	.1979 -2
19.82	.2226 -6	.1771 -4	.1257 -1	19.80	.6120 -4	1471 +1	2.4340483	116.07	2.892	.3804	458.1	5.925	77.33	.1127 -3	.1975 -2
19.84	.2210 -6	.1762 -4	.1254 -1	19.82	.6090 -4	1478 +1	2.4340792	116.08	2.889	.3804	459.1	5.925	77.48	.1121 -3	.1971 -2
19.86	.2195 -6	.1753 -4	.1252 -1	19.84	.6059 -4	1486 +1	2.4341099	116.10	2.886	.3804	460.0	5.925	77.64	.1116 -3	.1967 -2
19.88	.2179 -6	.1745 -4	.1249 -1	19.86	.6029 -4	1493 +1	2.4341405	116.11	2.883	.3804	460.9	5.925	77.79	.1110 -3	.1963 -2
19.90	.2165 -6	.1736 -4	.1247 -1	19.88	.6001 -4	1500 +1	2.4341711	116.13	2.880	.3804	461.9	5.925	77.95	.1105 -3	.1960 -2
19.92	.2150 -6	.1727 -4	.1244 -1	19.90	.5971 -4	1508 +1	2.4342015	116.14	2.878	.3804	462.8	5.925	78.10	.1099 -3	.1956 -2
19.94	.2135 -6	.1719 -4	.1242 -1	19.92	.5941 -4	1515 +1	2.4342319	116.15	2.875	.3804	463.7	5.926	78.26	.1094 -3	.1952 -2
19.96	.2120 -6	.1710 -4	.1240 -1	19.94	.5913 -4	1523 +1	2.4342622	116.17	2.872	.3804	464.6	5.926	78.41	.1088 -3	.1948 -2
19.98	.2105 -6	.1702 -4	.1237 -1	19.96	.5883 -4	1530 +1	2.4342924	116.18	2.869	.3804	465.6	5.926	78.57	.1083 -3	.1944 -2
20.00	.2091 -6	.1694 -4	.1235 -1	19.98	.5855 -4	1538 +1	2.4343225	116.20	2.866	.3804	466.5	5.926	78.72	.1078 -3	.1940 -2
20.20	.1952 -6	.1612 -4	.1211 -1	20.18	.5574 -4	1615 +1	2.4346186	116.34	2.838	.3803	475.9	5.927	80.29	.1026 -3	.1902 -2
20.40	.1823 -6	.1536 -4	.1187 -1	20.38	.5311 -4	1695 +1	2.4349062	116.47	2.810	.3803	465.4	5.929	81.86	.9778 -4	.1865 -2
20.60	.1704 -6	.1463 -4	.1165 -1	20.58	.5062 -4	1779 +1	2.4351855	116.61	2.782	.3802	494.9	5.930	83.46	.9319 -4	.1829 -2
20.80	.1594 -6	.1395 -4	.1143 -1	20.78	.4827 -4	1866 +1	2.4354569	116.74	2.756	.3802	504.6	5.932	85.07	.8887 -4	.1794 -2
21.00	.1492 -6	.1331 -4	.1121 -1	20.98	.4606 -4	1956 +1	2.4357207	116.87	2.729	.3802	514.3	5.933	86.69	.8478 -4	.1760 -2
21.20	.1397 -6	.1270 -4	.1100 -1	21.18	.4396 -4	2049 +1	2.4359772	117.00	2.704	.3801	524.2	5.934	88.34	.8091 -4	.1727 -2
21.40	.1309 -6	.1212 -4	.1080 -1	21.38	.4197 -4	2147 +1	2.4362265	117.12	2.678	.3801	534.1	5.935	89.99	.7725 -4	.1695 -2
21.60	.1227 -6	.1158 -4	.1060 -1	21.58	.4009 -4	2248 +1	2.4364690	117.24	2.654	.3800	544.2	5.936	91.66	.7380 -4	.1663 -2
21.80	.1151 -6	.1105 -4	.1041 -1	21.78	.3830 -4	2353 +1	2.4367050	117.36	2.629	.3800	554.3	5.938	93.35	.7052 -4	.1633 -2
22.00	.1081 -6	.1057 -4	.1023 -1	21.98	.3662 -4	2461 +1	2.4369346	117.48	2.605	.3800	564.5	5.939	95.05	.6742 -4	.1604 -2
22.20	.1015 -6	.1011 -4	.1004 -1	22.18	.3502 -4	2574 +1	2.4371581	117.60	2.582	.3799	574.8	5.940	96.77	.6447 -4	.1575 -2
22.40	.9541 -7	.9670 -5	.9867 -2	22.38	.3351 -4	2690 +1	2.4373757	117.71	2.559	.3799	585.2	5.941	98.51	.6168 -4	.1547 -2
22.60	.8971 -7	.9253 -5	.9694 -2	22.58	.3207 -4	2811 +1	2.4375876	117.82	2.536	.3799	595.7	5.942	100.3	.5904 -4	.1520 -2
22.80	.8439 -7	.8858 -5	.9527 -2	22.78	.3071 -4	2936 +1	2.4377940	117.93	2.514	.3798	606.3	5.943	102.0	.5653 -4	.1493 -2
23.00	.7943 -7	.8483 -5	.9363 -2	22.98	.2941 -4	3065 +1	2.4379951	118.04	2.492	.3798	617.0	5.944	103.8	.5414 -4	.1467 -2
23.20	.7480 -7	.8127 -5	.9204 -2	23.18	.2818 -4	3199 +1	2.4381911	118.15	2.470	.3798	627.8	5.945	105.6	.5188 -4	.1442 -2
23.40	.7048 -7	.7789 -5	.9049 -2	23.38	.2701 -4	3338 +1	2.4383821	118.25	2.449	.3797	638.7	5.946	107.4	.4972 -4	.1418 -2
23.60	.6644 -7	.7467 -5	.8897 -2	23.58	.2590 -4	3481 +1	2.4385683	118.36	2.429	.3797	649.6	5.947	109.2	.4768 -4	.1394 -2
23.80	.6266 -7	.7161 -5	.8750 -2	23.78	.2485 -4	3630 +1	2.4387499	118.46	2.408	.3797	660.7	5.948	111.1	.4573 -4	.1370 -2
24.00	.5913 -7	.6871 -5	.8606 -2	23.98	.2384 -4	3783 +1	2.4389270	118.56	2.388	.3796	671.8	5.948	112.9	.4388 -4	.1348 -2
24.20	.5582 -7	.6594 -5	.8465 -2	24.18	.2288 -4	3942 +1	2.4390998	118.65	2.368	.3796	683.1	5.949	114.8	.4211 -4	.1325 -2
24.40	.5272 -7	.6330 -5	.8328 -2	24.38	.2197 -4	4106 +1	2.4392683	118.75	2.349	.3796	694.4	5.950	116.7	.4044 -4	.1304 -2
24.60	.4981 -7	.6079 -5	.8195 -2	24.58	.2110 -4	4275 +1	2.4394328	118.85	2.330	.3796	705.9	5.951	118.6	.3884 -4	.1283 -2
24.80	.4709 -7	.5839 -5	.8064 -2	21.78	.2027 -4	4450 +1	2.4395934	118.94	2.311	.3795	717.4	5.952	120.5	.3731 -4	.1262 -2
25.00	.4454 -7	.5611 -5	.7937 -2	24.98	.1948 -4	4631 +1	2.4397502	119.03	2.292	.3795	729.0	5.952	122.5	.3586 -4	.1242 -2
25.20	.4214 -7	.5394 -5	.7812 -2	25.18	.1873 -4	4817 +1	2.4399033	119.12	2.274	.3795	740.7	5.953	124.4	.3447 -4	.1222 -2
25.40	.3989 -7	.5187 -5	.7690 -2	25.38	.1801 -4	5009 +1	2.4400528	119.21	2.256	.3795	752.5	5.954	126.4	.3315 -4	.1203 -2
25.60	.3777 -7	.4988 -5	.7572 -2	25.58	.1733 -4	5208 +1	2.4401988	119.30	2.239	.3794	764.4	5.955	128.4	.3189 -4	.1184 -2
25.80	.3578 -7	.4800 -5	.7456 -2	25.78	.1667 -4	5412 +1	2.4403415	119.38	2.221	.3794	776.4	5.955	130.4	.3069 -4	.1166 -2
26.00	.3391 -7	.4619 -5	.7342 -2	25.98	.1605 -4	5624 +1	2.4404809	119.47	2.204	.3794	788.5	5.956	132.4	.2953 -4	.1148 -2
26.20	.3216 -7	.4447 -5	.7231 -2	26.18	.1545 -4	5841 +1	2.4406172	119.55	2.187	.3794	800.7	5.957	134.4	.2844 -4	.1131 -2
26.40	.3050 -7	.4282 -5	.7123 -2	26.38	.1498 -4	6066 +1	2.4407504	119.63	2.171	.3794	813.0	5.957	136.5	.2739 -4	.1114 -2
26.60	.2894 -7	.4125 -5	.7017 -2	26.58	.1434 -4	6297 +1	2.4408806	119.71	2.154	.3793	825.3	5.958	138.5	.2638 -4	.1097 -2
26.80	.2747 -7	.3974 -5	.6913 -2	26.78	.1381 -4	6535 +1	2.4410080	119.79	2.138	.3793	837.8	5.959	140.6	.2542 -4	.1081 -2
27.00	.2609 -7	.3830 -5	.6812 -2	26.98	.1331 -4	6781 +1	2.4411325	119.87	2.123	.3793	850.3	5.959	142.7	.2450 -4	.1065 -2
27.20	.2479 -7	.3692 -5	.6713 -2	27.18	.1284 -4	7033 +1	2.4412544	119.95	2.107	.3793	863.0	5.960	144.8	.2362 -4	.1049 -2
27.40	.2355 -7	.3560 -5	.6616 -2	27.38	.1238 -4	7294 +1	2.4413736	120.03	2.092	.3793	875.7	5.960	146.9	.2278 -4	.1034 -2
27.60	.2239 -7	.3434 -5	.6521 -2	27.58	.1194 -4	7562 +1	2.4414902	120.10	2.076	.3792	888.6	5.961	149.1	.2197 -4	.1019 -2
27.80	.2130 -7	.3313 -5	.6428 -2	27.78	.1152 -4	7837 +1	2.4416043	120.18	2.061	.3792	901.5	5.961	151.2	.2120 -4	.1005 -2
28.00	.2026 -7	.3197 -5	.6337 -2	27.98	.1112 -4	8121 +1	2.4417160	120.25	2.047	.3792	914.5	5.962	153.4	.2046 -4	.9902 -3
28.20	.1928 -7	.3086 -5	.6248 -2	28.18	.1073 -4	8413 +1	2.4418254	120.32	2.032	.3792	927.6	5.963	155.6	.1975 -4	.9762 -3
28.40	.1836 -7	.2979 -5	.6161 -2	28.38	.1036 -4	8713 +1	2.4419325	120.39	2.018	.3792	940.8	5.963	157.8	.1907 -4	.9626 -3
28.60	.1748 -7	.2877 -5	.6076 -2	28.58	.1001 -4	9022 +1	2.4420373	120.46	2.004	.3792	954.1	5.964	160.0	.1842 -4	.9491 -3
28.80	.1665 -7	.2779 -5	.5992 -2	28.78	.9669 -5	9340 +1	2.4421400	120.53	1.990	.3791	967.5	5.964	162.2	.1779 -4	.9360 -3
29.00	.1587 -7	.2685 -5	.5910 -2	28.98	.9343 -5	9666 +1	2.4422406	120.60	1.976	.3791	981.0	5.965	164.5	.1719 -4	.9232 -3
29.20	.1513 -7	.2595 -5	.5830 -2	29.18	.9030 -5	1000 +2	2.4423391	120.67	1.963	.3791	994.6	5.965	166.7	.1662 -4	.9106 -3
29.40	.1443 -7	.2509 -5	.5751 -2	29.38	.8730 -5	1035 +2	2.4424356	120.73	1.949	.3791	1008	5.966	169.0	.1606 -4	.8983 -3
29.60	.1376 -7	.2425 -5	.5674 -2	29.58	.8440 -5	1070 +2	2.4425302	120.80	1.936	.3791	1022	5.966	171.3	.1553 -4	.8860 -3
29.80	.1313 -7	.2346 -5	.5599 -2	29.78	.8164 -5	1107 +2	2.4426230	120.86	1.923	.3791	1036	5.966	173.6	.1502 -4	.8743 -3
30.00	.1254 -7	.2269 -5	.5525 -2	29.98	.7897 -5	1144 +2	2.4427138	120.93	1.910	.3790	1050	5.967	175.9	.1453 -4	.8626 -3
30.20	.1197 -7	.2195 -5	.5452 -2	30.18	.7641 -5	1182 +2	2.4428029	120.99	1.898	.3790	1064	5.967	178.3	.1406 -4	.8512 -3
30.40	.1143 -7	.2124 -5	.5381 -2	30.38	.7395 -5	1222 +2	2.4428902	121.05	1.885	.3790	1078	5.968	180.6	.1361 -4	.8400 -3
30.60	.1092 -7	.2056 -5	.5312 -2	30.58	.7158 -5	1262 +2	2.4429759	121.11	1.873	.3790	1092	5.968	183.0	.1317 -4	.8292 -3
30.80	.1044 -7	.1991 -5	.5243 -2	30.78	.6931 -5	1304 +2	2.4430599	121.17	1.861	.3790	1107	5.969	185.4	.1275 -4	.8185 -3
31.00	.9977 -8	.1928 -5	.5176 -2	30.98	.6711 -5	1346 +2	2.4431423	121.23	1.849	.3790	1121	5.969	187.8	.1235 -4	.8079 -3
31.20	.9540 -8	.1867 -5	.5110 -2	31.18	.6501 -5	1390 +2	2.4432231	121.29	1.837	.3790	1136	5.969	190.2	.1196 -4	.7976 -3
31.40	.9124 -8	.1808 -5	.5046 -2	31.38	.6297 -5	1435 +2	2.4433023	121.35	1.825	.3789	1150	5.970	192.7	.1159 -4	.7874 -3
31.60	.8730 -8	.1752 -5	.4982 -2	31.58	.6102 -5	1481 +2	2.4433801	121.41	1.813	.3789	1165	5.970	195.1	.1123 -4	.7775 -3
31.80	.8354 -8	.1698 -5	.4920 -2	31.78	.5914 -5	1528 +2	2.4434564	121.46	1.802	.3789	1180	5.971	197.6	.1088 -4	.7677 -3
32.00	.7997 -8	.1646 -5	.4859 -2	31.98	.5733 -5	1576 +2	2.4435314	121.52	1.791	.3789	1195	5.971	200.1	.1055 -4	.7583 -3
32.20	.7658 -8	.1596 -5	.4799 -2	32.18	.5558 -5	1626 +2	2.4436049	121.57	1.780	.3789	1210	5.971	202.6	.1023 -4	.7488 -3
32.40	.7334 -8	.1547 -5	.4740 -2	32.38	.5389 -5	1677 +2	2.4436770	121.63	1.769	.3789	1225	5.972	205.1	.9916 -5	.7396 -3
32.60	.7026 -8	.1501 -5	.4683 -2	32.58	.5227 -5	1729 +2	2.4437479	121.68	1.758	.3789	1240	5.972	207.6	.9618 -5	.7305 -3
32.80	.6733 -8	.1456 -5	.4626 -2	32.78	.5071 -5	1782 +2	2.4438175	121.74	1.747	.3789	1255	5.972	210.1	.9330 -5	.7217 -3

TABLE II.—SUPERSONIC FLOW—Continued

$\gamma=7/5$

M or M_1	$\frac{p}{p_t}$	$\frac{\rho}{\rho_t}$	$\frac{T}{T_t}$	β	$\frac{q}{p_t}$	$\frac{A}{A_*}$	$\frac{V}{a_*}$	ν	μ	M_2	$\frac{p_2}{p_1}$	$\frac{\rho_2}{\rho_1}$	$\frac{T_2}{T_1}$	$\frac{p_{t_2}}{p_{t_1}}$	$\frac{p_1}{p_{t_2}}$
33.00	.6454 $^{-8}$	.1412 $^{-5}$	.4570 $^{-2}$	32.98	.4920 $^{-5}$	1837 $^{+2}$	2.4438858	121.79	1.737	.3789	1270	5.973	212.7	.9053 $^{-5}$	.7129 $^{-3}$
33.20	.6188 $^{-8}$	.1370 $^{-5}$	.4516 $^{-2}$	33.18	.4774 $^{-5}$	1893 $^{+2}$	2.4439529	121.84	1.726	.3788	1286	5.973	215.3	.8785 $^{-5}$	.7044 $^{-3}$
33.40	.5935 $^{-8}$	.1330 $^{-5}$	.4462 $^{-2}$	33.39	.4634 $^{-5}$	1950 $^{+2}$	2.4440188	121.89	1.716	.3788	1301	5.973	217.9	.8527 $^{-5}$	.6960 $^{-3}$
33.60	.5692 $^{-8}$	.1291 $^{-5}$	.4409 $^{-2}$	33.59	.4499 $^{-5}$	2009 $^{+2}$	2.4440835	121.94	1.706	.3788	1317	5.974	220.5	.8277 $^{-5}$	.6878 $^{-3}$
33.80	.5462 $^{-8}$	.1253 $^{-5}$	.4358 $^{-2}$	33.79	.4368 $^{-5}$	2069 $^{+2}$	2.4441471	121.99	1.695	.3788	1333	5.974	223.1	.8037 $^{-5}$	.6796 $^{-3}$
34.00	.5242 $^{-8}$	.1217 $^{-5}$	.4307 $^{-2}$	33.99	.4242 $^{-5}$	2131 $^{+2}$	2.4442095	122.04	1.685	.3788	1349	5.974	225.7	.7805 $^{-5}$	.6716 $^{-3}$
34.20	.5032 $^{-8}$	.1182 $^{-5}$	.4257 $^{-2}$	34.19	.4120 $^{-5}$	2194 $^{+2}$	2.4442709	122.09	1.676	.3788	1364	5.975	228.4	.7581 $^{-5}$	.6638 $^{-3}$
34.40	.4832 $^{-8}$	.1148 $^{-5}$	.4208 $^{-2}$	34.39	.4002 $^{-5}$	2259 $^{+2}$	2.4443312	122.14	1.666	.3788	1380	5.975	231.0	.7364 $^{-5}$	.6561 $^{-3}$
34.60	.4640 $^{-8}$	.1116 $^{-5}$	.4159 $^{-2}$	34.59	.3889 $^{-5}$	2325 $^{+2}$	2.4443905	122.19	1.656	.3788	1397	5.975	233.7	.7155 $^{-5}$	.6486 $^{-3}$
34.80	.4457 $^{-8}$	.1084 $^{-5}$	.4112 $^{-2}$	34.79	.3779 $^{-5}$	2392 $^{+2}$	2.4444488	122.24	1.647	.3788	1413	5.975	236.4	.6952 $^{-5}$	.6411 $^{-3}$
35.00	.4283 $^{-8}$	.1054 $^{-5}$	.4065 $^{-2}$	34.99	.3672 $^{-5}$	2462 $^{+2}$	2.4445060	122.28	1.637	.3788	1429	5.976	239.1	.6757 $^{-5}$	.6338 $^{-3}$
35.20	.4116 $^{-8}$	.1024 $^{-5}$	.4019 $^{-2}$	35.19	.3570 $^{-5}$	2532 $^{+2}$	2.4445623	122.33	1.628	.3787	1445	5.976	241.9	.6568 $^{-5}$	.6267 $^{-3}$
35.40	.3957 $^{-8}$	.9956 $^{-6}$	.3974 $^{-2}$	35.39	.3471 $^{-5}$	2605 $^{+2}$	2.4446177	122.37	1.619	.3787	1462	5.976	244.6	.6385 $^{-5}$	.6197 $^{-3}$
35.60	.3804 $^{-8}$	.9680 $^{-6}$	.3930 $^{-2}$	35.59	.3375 $^{-5}$	2679 $^{+2}$	2.4446721	122.42	1.610	.3787	1478	5.976	247.4	.6210 $^{-5}$	.6126 $^{-3}$
35.80	.3658 $^{-8}$	.9414 $^{-6}$	.3886 $^{-2}$	35.79	.3282 $^{-5}$	2754 $^{+2}$	2.4447256	122.47	1.601	.3787	1495	5.977	250.2	.6039 $^{-5}$	.6059 $^{-3}$
36.00	.3519 $^{-8}$	.9156 $^{-6}$	.3843 $^{-2}$	35.99	.3192 $^{-5}$	2832 $^{+2}$	2.4447783	122.51	1.592	.3787	1512	5.977	252.9	.5874 $^{-5}$	.5991 $^{-3}$
36.20	.3386 $^{-8}$	.8907 $^{-6}$	.3801 $^{-2}$	36.19	.3106 $^{-5}$	2911 $^{+2}$	2.4448300	122.55	1.583	.3787	1529	5.977	255.8	.5714 $^{-5}$	.5925 $^{-3}$
36.40	.3258 $^{-8}$	.8666 $^{-6}$	.3760 $^{-2}$	36.39	.3022 $^{-5}$	2992 $^{+2}$	2.4448810	122.60	1.574	.3787	1546	5.977	258.6	.5560 $^{-5}$	.5860 $^{-3}$
36.60	.3136 $^{-8}$	.8433 $^{-6}$	.3719 $^{-2}$	36.59	.2941 $^{-5}$	3075 $^{+2}$	2.4449311	122.64	1.566	.3787	1563	5.978	261.4	.5410 $^{-5}$	.5797 $^{-3}$
36.80	.3019 $^{-8}$	.8207 $^{-6}$	.3679 $^{-2}$	36.79	.2862 $^{-5}$	3159 $^{+2}$	2.4449803	122.68	1.557	.3787	1580	5.978	264.3	.5265 $^{-5}$	.5734 $^{-3}$
37.00	.2907 $^{-8}$	.7988 $^{-6}$	.3639 $^{-2}$	36.99	.2786 $^{-5}$	3246 $^{+2}$	2.4450288	122.72	1.549	.3787	1597	5.978	267.1	.5126 $^{-5}$	.5671 $^{-3}$
37.20	.2800 $^{-8}$	.7777 $^{-6}$	.3600 $^{-2}$	37.19	.2712 $^{-5}$	3334 $^{+2}$	2.4450765	122.77	1.540	.3787	1614	5.978	270.0	.4990 $^{-5}$	.5611 $^{-3}$
37.40	.2697 $^{-8}$	.7572 $^{-6}$	.3562 $^{-2}$	37.39	.2641 $^{-5}$	3424 $^{+2}$	2.4451235	122.81	1.532	.3787	1632	5.979	272.9	.4858 $^{-5}$	.5551 $^{-3}$
37.60	.2598 $^{-8}$	.7373 $^{-6}$	.3524 $^{-2}$	37.59	.2572 $^{-5}$	3516 $^{+2}$	2.4451697	122.85	1.524	.3787	1649	5.979	275.8	.4732 $^{-5}$	.5492 $^{-3}$
37.80	.2504 $^{-8}$	.7181 $^{-6}$	.3487 $^{-2}$	37.79	.2504 $^{-5}$	3611 $^{+2}$	2.4452152	122.89	1.516	.3786	1667	5.979	278.8	.4608 $^{-5}$	.5434 $^{-3}$
38.00	.2414 $^{-8}$	.6995 $^{-6}$	.3451 $^{-2}$	37.99	.2440 $^{-5}$	3706 $^{+2}$	2.4452599	122.93	1.508	.3786	1685	5.979	281.7	.4489 $^{-5}$	.5377 $^{-3}$
38.20	.2327 $^{-8}$	.6814 $^{-6}$	.3415 $^{-2}$	38.19	.2377 $^{-5}$	3805 $^{+2}$	2.4453040	122.97	1.500	.3786	1702	5.980	284.7	.4373 $^{-5}$	.5321 $^{-3}$
38.40	.2244 $^{-8}$	.6639 $^{-6}$	.3379 $^{-2}$	38.39	.2316 $^{-5}$	3905 $^{+2}$	2.4453474	123.00	1.492	.3786	1720	5.980	287.7	.4260 $^{-5}$	.5266 $^{-3}$
38.60	.2164 $^{-8}$	.6469 $^{-6}$	.3345 $^{-2}$	38.59	.2257 $^{-5}$	4007 $^{+2}$	2.4453901	123.04	1.485	.3786	1738	5.980	290.7	.4152 $^{-5}$	.5212 $^{-3}$
38.80	.2087 $^{-8}$	.6305 $^{-6}$	.3310 $^{-2}$	38.79	.2199 $^{-5}$	4112 $^{+2}$	2.4454321	123.08	1.477	.3786	1756	5.980	293.7	.4046 $^{-5}$	.5158 $^{-3}$
39.00	.2013 $^{-8}$	.6145 $^{-6}$	.3277 $^{-2}$	38.99	.2144 $^{-5}$	4219 $^{+2}$	2.4454735	123.12	1.469	.3786	1774	5.980	296.7	.3944 $^{-5}$	.5105 $^{-3}$
39.20	.1943 $^{-8}$	.5991 $^{-6}$	.3243 $^{-2}$	39.19	.2090 $^{-5}$	4327 $^{+2}$	2.4455143	123.16	1.462	.3786	1793	5.981	299.7	.3845 $^{-5}$	.5053 $^{-3}$
39.40	.1875 $^{-8}$	.5841 $^{-6}$	.3211 $^{-2}$	39.39	.2038 $^{-5}$	4438 $^{+2}$	2.4455545	123.19	1.454	.3786	1811	5.981	302.8	.3749 $^{-5}$	.5002 $^{-3}$
39.60	.1810 $^{-8}$	.5695 $^{-6}$	.3178 $^{-2}$	39.59	.1987 $^{-5}$	4552 $^{+2}$	2.4455940	123.23	1.447	.3786	1829	5.981	305.9	.3655 $^{-5}$	.4952 $^{-3}$
39.80	.1748 $^{-8}$	.5554 $^{-6}$	.3147 $^{-2}$	39.79	.1938 $^{-5}$	4667 $^{+2}$	2.4456330	123.27	1.440	.3786	1848	5.981	309.0	.3565 $^{-5}$	.4902 $^{-3}$
40.00	.1688 $^{-8}$	.5417 $^{-6}$	.3115 $^{-2}$	39.99	.1890 $^{-5}$	4785 $^{+2}$	2.4456714	123.30	1.433	.3786	1867	5.981	312.1	.3477 $^{-5}$	.4853 $^{-3}$
40.20	.1630 $^{-8}$	.5284 $^{-6}$	.3084 $^{-2}$	40.19	.1844 $^{-5}$	4906 $^{+2}$	2.4457092	123.34	1.425	.3786	1885	5.982	315.2	.3392 $^{-5}$	.4805
40.40	.1574 $^{-8}$	.5155 $^{-6}$	.3054 $^{-2}$	40.39	.1799 $^{-5}$	5028 $^{+2}$	2.4457464	123.37	1.418	.3786	1904	5.982	318.3	.3309 $^{-5}$	.4757
40.60	.1521 $^{-8}$	.5029 $^{-6}$	.3024 $^{-2}$	40.59	.1755 $^{-5}$	5154 $^{+2}$	2.4457831	123.41	1.411	.3786	1923	5.982	321.5	.3229 $^{-5}$	.471[illegible]
40.80	.1470 $^{-8}$	.4908 $^{-6}$	.2995 $^{-2}$	40.79	.1713 $^{-5}$	5281 $^{+2}$	2.4458193	123.44	1.404	.3785	1942	5.982	324.6	.3151 $^{-5}$	.4665
41.00	.1420 $^{-8}$	.4789 $^{-6}$	.2965 $^{-2}$	40.99	.1671 $^{-5}$	5412 $^{+2}$	2.4458549	123.48	1.398	.3785	1961	5.982	327.8	.3075 $^{-5}$	.4619
41.20	.1373 $^{-8}$	.4675 $^{-6}$	.2937 $^{-2}$	41.19	.1631 $^{-5}$	5544 $^{+2}$	2.4458901	123.51	1.391	.3785	1980	5.982	331.0	.3001 $^{-5}$	.4575 $^{-3}$
41.40	.1327 $^{-8}$	.4563 $^{-6}$	.2909 $^{-2}$	41.39	.1592 $^{-5}$	5680 $^{+2}$	2.4459247	123.54	1.384	.3785	2000	5.983	334.2	.2929 $^{-5}$	.4531 $^{-3}$
41.60	.1283 $^{-8}$	.4455 $^{-6}$	.2881 $^{-2}$	41.59	.1555 $^{-5}$	5818 $^{+2}$	2.4459588	123.58	1.377	.3785	2019	5.983	337.4	.2860 $^{-5}$	.4487 $^{-3}$
41.80	.1241 $^{-8}$	.4349 $^{-6}$	.2854 $^{-2}$	41.79	.1518 $^{-5}$	5959 $^{+2}$	2.4459924	123.61	1.371	.3785	2038	5.983	340.7	.2793 $^{-5}$	.4444 $^{-3}$
42.00	.1201 $^{-8}$	.4247 $^{-6}$	.2827 $^{-2}$	41.99	.1482 $^{-5}$	6102 $^{+2}$	2.4460256	123.64	1.364	.3785	2058	5.983	343.9	.2727 $^{-5}$	.4402 $^{-3}$
42.20	.1161 $^{-8}$	.4148 $^{-6}$	.2800 $^{-2}$	42.19	.1448 $^{-5}$	6248 $^{+2}$	2.4460583	123.67	1.358	.3785	2078	5.983	347.2	.2663 $^{-5}$	.4360 $^{-3}$
42.40	.1124 $^{-8}$	.4051 $^{-6}$	.2774 $^{-2}$	42.39	.1414 $^{-5}$	6397 $^{+2}$	2.4460905	123.71	1.351	.3785	2097	5.983	350.5	.2602 $^{-5}$	.4319 $^{-3}$
42.60	.1087 $^{-8}$	.3957 $^{-6}$	.2748 $^{-2}$	42.59	.1381 $^{-5}$	6549 $^{+2}$	2.4461223	123.74	1.345	.3785	2117	5.984	353.8	.2541 $^{-5}$	.4279 $^{-3}$
42.80	.1052 $^{-8}$	.3866 $^{-6}$	.2722 $^{-2}$	42.79	.1349 $^{-5}$	6704 $^{+2}$	2.4461536	123.77	1.339	.3785	2137	5.984	357.1	.2483 $^{-5}$	.4239 $^{-3}$
43.00	.1019 $^{-8}$	.3777 $^{-6}$	.2697 $^{-2}$	42.99	.1318 $^{-5}$	6861 $^{+2}$	2.4461845	123.80	1.333	.3785	2157	5.984	360.5	.2426 $^{-5}$	.4200 $^{-3}$
43.20	.9861 $^{-9}$	.3691 $^{-6}$	.2672 $^{-2}$	43.19	.1288 $^{-5}$	7022 $^{+2}$	2.4462150	123.83	1.326	.3785	2177	5.984	363.8	.2370 $^{-5}$	.4161 $^{-3}$
43.40	.9548 $^{-9}$	.3607 $^{-6}$	.2648 $^{-2}$	43.39	.1259 $^{-5}$	7186 $^{+2}$	2.4462451	123.86	1.320	.3785	2197	5.984	367.2	.2316 $^{-5}$	.4122 $^{-3}$
43.60	.9246 $^{-9}$	.3525 $^{-6}$	.2623 $^{-2}$	43.59	.1230 $^{-5}$	7352 $^{+2}$	2.4462747	123.89	1.314	.3785	2218	5.984	370.6	.2264 $^{-5}$	.4084 $^{-3}$
43.80	.8956 $^{-9}$	.3445 $^{-6}$	.2600 $^{-2}$	43.79	.1203 $^{-5}$	7522 $^{+2}$	2.4463339	123.92	1.308	.3785	2238	5.984	374.0	.2213 $^{-5}$	.4048 $^{-3}$
44.00	.8676 $^{-9}$	.3368 $^{-6}$	.2576 $^{-2}$	43.99	.1176 $^{-5}$	7694 $^{+2}$	2.4463326	123.95	1.302	.3785	2259	5.985	377.4	.2163 $^{-5}$	.4011 $^{-3}$
44.20	.8405 $^{-9}$	.3293 $^{-6}$	.2553 $^{-2}$	44.19	.1150 $^{-5}$	7870 $^{+2}$	2.4463612	123.98	1.296	.3785	2279	5.985	380.8	.2115 $^{-5}$	.3975 $^{-3}$
44.40	.8144 $^{-9}$	.3219 $^{-6}$	.2530 $^{-2}$	44.39	.1124 $^{-5}$	8049 $^{+2}$	2.4463893	124.01	1.291	.3785	2300	5.985	384.3	.2068 $^{-5}$	.3939 $^{-3}$
44.60	.7893 $^{-9}$	.3148 $^{-6}$	.2507 $^{-2}$	44.59	.1099 $^{-5}$	8232 $^{+2}$	2.4464170	124.04	1.285	.3785	2321	5.985	387.7	.2022 $^{-5}$	.3904 $^{-3}$
44.80	.7650 $^{-9}$	.3078 $^{-6}$	.2485 $^{-2}$	44.79	.1075 $^{-5}$	8418 $^{+2}$	2.4464443	124.07	1.279	.3784	2341	5.985	391.2	.1977 $^{-5}$	.3869 $^{-3}$
45.00	.7416 $^{-9}$	.3011 $^{-6}$	.2463 $^{-2}$	44.99	.1051 $^{-5}$	8606 $^{+2}$	2.4464713	124.10	1.273	.3784	2362	5.985	394.7	.1934 $^{-5}$	.3835 $^{-3}$
45.20	.7190 $^{-9}$	.2945 $^{-6}$	.2441 $^{-2}$	45.19	.1028 $^{-5}$	8798 $^{+2}$	2.4464979	124.12	1.268	.3784	2383	5.985	398.2	.1892 $^{-5}$	.3801 $^{-3}$
45.40	.6971 $^{-9}$	.2881 $^{-6}$	.2420 $^{-2}$	45.39	.1006 $^{-5}$	8995 $^{+2}$	2.4465241	124.15	1.262	.3784	2405	5.986	401.7	.1851 $^{-5}$	.3767 $^{-3}$
45.60	.6760 $^{-9}$	.2818 $^{-6}$	.2399 $^{-2}$	45.59	.9840 $^{-6}$	9194 $^{+2}$	2.4465500	124.18	1.257	.3784	2426	5.986	405.3	.1810 $^{-5}$	.3735 $^{-3}$
45.80	.6557 $^{-9}$	.2758 $^{-6}$	.2378 $^{-2}$	45.79	.9629 $^{-6}$	9396 $^{+2}$	2.4465756	124.21	1.251	.3784	2447	5.986	408.8	.1771 $^{-5}$	.3702 $^{-3}$
46.00	.6361 $^{-9}$	.2698 $^{-6}$	.2357 $^{-2}$	45.99	.9422 $^{-6}$	9603 $^{+2}$	2.4466009	124.23	1.246	.3784	2469	5.986	412.4	.1733 $^{-5}$	.3670 $^{-3}$
46.20	.6171 $^{-9}$	.2641 $^{-6}$	.2337 $^{-2}$	46.19	.9220 $^{-6}$	9813 $^{+2}$	2.4466258	124.26	1.240	.3784	2490	5.986	416.0	.1696 $^{-5}$	.3638 $^{-3}$
46.40	.5987 $^{-9}$	.2584 $^{-6}$	.2317 $^{-2}$	46.39	.9023 $^{-6}$	1003 $^{+3}$	2.4466504	124.29	1.235	.3784	2512	5.986	419.6	.1660 $^{-5}$	.3607 $^{-3}$
46.60	.5810 $^{-9}$	.2529 $^{-6}$	.2297 $^{-2}$	46.59	.8832 $^{-6}$	1024 $^{+3}$	2.4466746	124.31	1.230	.3784	2533	5.986	423.2	.1625 $^{-5}$	.3576 $^{-3}$
46.80	.5639 $^{-9}$	.2476 $^{-6}$	.2278 $^{-2}$	46.79	.8646 $^{-6}$	1047 $^{+3}$	2.4466986	124.34	1.224	.3784	2555	5.986	426.8	.1591 $^{-5}$	.3546 $^{-3}$
47.00	.5474 $^{-9}$	.2424 $^{-6}$	.2258 $^{-2}$	46.99	.8464 $^{-6}$	1069 $^{+3}$	2.4467223	124.37	1.219	.3784	2577	5.986	430.5	.1557 $^{-5}$	.3516 $^{-3}$
47.20	.5314 $^{-9}$	.2373 $^{-6}$	.2239 $^{-2}$	47.19	.8287 $^{-6}$	1092 $^{+3}$	2.4467456	124.39	1.214	.3784	2599	5.987	434.1	.1525 $^{-5}$	.3486 $^{-3}$
47.40	.5159 $^{-9}$	.2323 $^{-6}$	.2221 $^{-2}$	47.39	.8114 $^{-6}$	1115 $^{+3}$	2.4467687	124.42	1.209	.3784	2621	5.987	437.8	.1493 $^{-5}$	.3457 $^{-3}$
47.60	.5009 $^{-9}$	.2275 $^{-6}$	.2202 $^{-2}$	47.59	.7945 $^{-6}$	1139 $^{+3}$	2.4467915	124.44	1.204	.3784	2643	5.987	441.5	.1462 $^{-5}$	.3427 $^{-3}$
47.80	.4865 $^{-9}$	.2226 $^{-6}$	.2184 $^{-2}$	47.79	.7782 $^{-6}$	1163 $^{+3}$	2.4468140	124.47	1.199	.3784	2666	5.987	445.2	.1431 $^{-5}$	.3399 $^{-3}$
48.00	.4725 $^{-9}$	.2182 $^{-6}$	.2165 $^{-2}$	47.99	.7620 $^{-6}$	1187 $^{+3}$	2.4468362	124.49	1.194	.3784	2688	5.987	448.9	.1402 $^{-5}$	.3370 $^{-3}$
48.20	.4590 $^{-9}$	.2137 $^{-6}$	.2148 $^{-2}$	48.19	.7464 $^{-6}$	1212 $^{+3}$	2.4468581	124.52	1.189	.3784	2710	5.987	452.7	.1373 $^{-5}$	.3342 $^{-3}$
48.40	.4459 $^{-9}$	.2094 $^{-6}$	.2130 $^{-2}$	48.39	.7312 $^{-6}$	1238 $^{+3}$	2.4468798	124.54	1.184	.3784	2733	5.987	456.4	.1345 $^{-5}$	.3315 $^{-3}$
48.60	.4332 $^{-9}$	.2051 $^{-6}$	.2112 $^{-2}$	48.59	.7163 $^{-6}$	1263 $^{+3}$	2.4469012	124.56	1.179	.3784	2756	5.987	460.2	.1318 $^{-5}$	.3288 $^{-3}$
48.80	.4210 $^{-9}$	.2009 $^{-6}$	.2095 $^{-2}$	48.79	.7018 $^{-6}$	1289 $^{+3}$	2.4469223	124.59	1.174	.3784	2778	5.987	464.0	.1291 $^{-5}$	.326[illegible]
49.00	.4091 $^{-9}$	.1969 $^{-6}$	.2078 $^{-2}$	48.99	.6876 $^{-6}$	1316 $^{+3}$	2.4469432	124.61	1.169	.3784	2801	5.988	467.8	.1265 $^{-5}$	.32[illegible]
49.20	.3976 $^{-9}$	.1929 $^{-6}$	.2061 $^{-2}$	49.19	.6738 $^{-6}$	1343 $^{+3}$	2.4469639	124.64	1.165	.3784	2824	5.988	471.6	.1240 $^{-5}$	.32[illegible]
49.40	.3865 $^{-9}$	.1890 $^{-6}$	.2045 $^{-2}$	49.39	.6603 $^{-6}$	1370 $^{+3}$	2.4469842	124.66	1.160	.3784	2847	5.988	475.5	.1215 $^{-5}$	.31[illegible]
49.60	.3758 $^{-9}$	.1853 $^{-6}$	.2028 $^{-2}$	49.59	.6472 $^{-6}$	1398 $^{+3}$	2.4470044	124.68	1.155	.3784	2870	5.988	479.3	.1191 $^{-5}$	.315[illegible]
49.80	.3653 $^{-9}$	.1816 $^{-6}$	.2012 $^{-2}$	49.79	.6342 $^{-6}$	1427 $^{+3}$	2.4470243	124.71	1.151	.3784	2893	5.988	483.2	.1167 $^{-5}$	.3131 $^{-3}$
50.00	.3553 $^{-9}$	.1780 $^{-6}$	.1996 $^{-2}$	49.99	.6217 $^{-6}$	1456 $^{+3}$	2.4470439	124.73	1.146	.3783	2917	5.988	487.1	.1144 $^{-5}$	.3106 $^{-3}$
51.00	.3093 $^{-9}$	.1612 $^{-6}$	.1919 $^{-2}$	50.99	.5632 $^{-6}$	1607 $^{+3}$	2.4471388	124.84	1.124	.3783	3034	5.989	506.7	.1036 $^{-5}$	.2955 $^{-3}$
52.00	.2701 $^{-9}$	.1464 $^{-6}$	.1846 $^{-2}$	51.99	.5113 $^{-6}$	1770 $^{+3}$	2.4472282	124.95	1.102	.3783	3155	5.989	526.7	.9406 $^{-6}$	.2872 $^{-3}$
53.00	.2365 $^{-9}$	.1331 $^{-6}$	.1777 $^{-2}$	52.99	.4649 $^{-6}$	1947 $^{+3}$	2.4473126	125.05	1.081	.3783	3277	5.989	547.1	.8553 $^{-6}$	.2765 $^{-3}$
54.00	.2075 $^{-9}$	.1212 $^{-6}$	.1712 $^{-2}$	53.99	.4235 $^{-6}$	2137 $^{+3}$	2.4473924	125.15	1.061	.3783	3402	5.990	567.9	.7792 $^{-6}$	.2663 $^{-3}$

TABLE II.—SUPERSONIC FLOW—Concluded

$\gamma=7.5$

M or M_1	$\frac{p}{p_t}$	$\frac{\rho}{\rho_t}$	$\frac{T}{T_t}$	β	$\frac{q}{p_t}$	$\frac{A}{A_*}$	$\frac{V}{a_*}$	ν	μ	M_2	$\frac{p_2}{p_1}$	$\frac{\rho_2}{\rho_1}$	$\frac{T_2}{T_1}$	$\frac{p_{t_2}}{p_{t_1}}$	$\frac{p_1}{p_{t_2}}$
55.00	.1826 $^{-9}$	.1106 $^{-6}$	.1650 $^{-2}$	54.99	.3866 $^{-6}$	2341 $^{+3}$	2.4474679	125.25	1.042	.3783	3529	5.990	589.1	.7111 $^{-6}$	.2567 $^{-3}$
56.00	.1609 $^{-9}$	.1011 $^{-6}$	.1592 $^{-2}$	55.99	.3533 $^{-6}$	2562 $^{+3}$	2.4475394	125.34	1.023	.3783	3659	5.990	610.7	.6499 $^{-6}$	.2476 $^{-3}$
57.00	.1422 $^{-9}$	.9256 $^{-7}$	.1537 $^{-2}$	56.99	.3235 $^{-6}$	2798 $^{+3}$	2.4476071	125.43	1.005	.3783	3790	5.991	632.7	.5950 $^{-6}$	.2390 $^{-3}$
58.00	.1259 $^{-9}$	.8485 $^{-7}$	.1484 $^{-2}$	57.99	.2965 $^{-6}$	3052 $^{+3}$	2.4476714	125.52	.9879	.3783	3925	5.991	655.1	.5455 $^{-6}$	.2308 $^{-3}$
59.00	.1118 $^{-9}$	.7791 $^{-7}$	.1434 $^{-2}$	58.99	.2723 $^{-6}$	3324 $^{+3}$	2.4477325	125.60	.9712	.3782	4051	5.991	677.8	.5009 $^{-6}$	.2231 $^{-3}$
60.00	.9937 $^{-10}$	.7165 $^{-7}$	.1387 $^{-2}$	59.99	.2504 $^{-6}$	3615 $^{+3}$	2.4477905	125.68	.9550	.3782	4200	5.992	700.9	.4605 $^{-6}$	.2157 $^{-3}$
61.00	.8852 $^{-10}$	.6596 $^{-7}$	.1342 $^{-2}$	60.99	.2305 $^{-6}$	3926 $^{+3}$	2.4478457	125.76	.9393	.3782	4341	5.992	724.5	.4241 $^{-6}$	.2037 $^{-3}$
62.00	.7900 $^{-10}$	.6082 $^{-7}$	.1299 $^{-2}$	61.99	.2126 $^{-6}$	4258 $^{+3}$	2.4478982	125.84	.9241	.3782	4485	5.992	748.4	.3911 $^{-6}$	.2020 $^{-3}$
63.00	.7065 $^{-10}$	.5615 $^{-7}$	.1258 $^{-2}$	62.99	.1963 $^{-6}$	4612 $^{+3}$	2.4479483	125.91	.9095	.3782	4630	5.993	772.7	.3611 $^{-6}$	.1957 $^{-3}$
64.00	.6328 $^{-10}$	.5190 $^{-7}$	.1219 $^{-2}$	63.99	.1814 $^{-6}$	4990 $^{+3}$	2.4479961	125.98	.8953	.3782	4779	5.993	797.4	.3338 $^{-6}$	.1896 $^{-3}$
65.00	.5678 $^{-10}$	.4803 $^{-7}$	.1182 $^{-2}$	64.99	.1679 $^{-6}$	5391 $^{+3}$	2.4480416	126.05	.8815	.3782	4929	5.993	822.5	.3039 $^{-6}$	.1838 $^{-3}$
66.00	.5103 $^{-10}$	.4451 $^{-7}$	.1147 $^{-2}$	65.99	.1556 $^{-6}$	5818 $^{+3}$	2.4480851	126.12	.8682	.3782	5082	5.993	847.9	.2863 $^{-6}$	.1783 $^{-3}$
67.00	.4594 $^{-10}$	.4129 $^{-7}$	.1113 $^{-2}$	66.99	.1444 $^{-6}$	6271 $^{+3}$	2.4481257	126.18	.8552	.3782	5237	5.993	873.8	.2655 $^{-6}$	.1730 $^{-3}$
68.00	.4141 $^{-10}$	.3834 $^{-7}$	.1080 $^{-2}$	67.99	.1340 $^{-6}$	6754 $^{+3}$	2.4481665	126.24	.8426	.3782	5395	5.994	900.1	.2466 $^{-6}$	.1679 $^{-3}$
69.00	.3740 $^{-10}$	.3565 $^{-7}$	.1049 $^{-2}$	68.99	.1246 $^{-6}$	7264 $^{+3}$	2.4482045	126.30	.8304	.3782	5554	5.994	926.7	.2294 $^{-6}$	.1631 $^{-3}$
70.00	.3382 $^{-10}$	.3318 $^{-7}$	.1019 $^{-2}$	69.99	.1160 $^{-6}$	7804 $^{+3}$	2.4482410	126.36	.8185	.3782	5717	5.994	953.7	.2134 $^{-6}$	.1585 $^{-3}$
71.00	.3062 $^{-10}$	.3091 $^{-7}$	.9909 $^{-3}$	70.99	.1081 $^{-6}$	8378 $^{+3}$	2.4482759	126.42	.8070	.3782	5881	5.994	981.1	.1988 $^{-6}$	.1540 $^{-3}$
72.00	.2777 $^{-10}$	.2882 $^{-7}$	.9636 $^{-3}$	71.99	.1008 $^{-6}$	8984 $^{+3}$	2.4483093	126.48	.7958	.3782	6048	5.994	1009	.1854 $^{-6}$	.1498 $^{-3}$
73.00	.2522 $^{-10}$	.2690 $^{-7}$	.9374 $^{-3}$	72.99	.9406 $^{-7}$	9625 $^{+3}$	2.4483414	126.54	.7849	.3781	6217	5.994	1037	.1730 $^{-6}$	.1457 $^{-3}$
74.00	.2293 $^{-10}$	.2513 $^{-7}$	.9122 $^{-3}$	73.99	.8789 $^{-7}$	1030 $^{+4}$	2.4483722	126.59	.7742	.3781	6389	5.995	1066	.1617 $^{-6}$	.1418 $^{-3}$
75.00	.2088 $^{-10}$	.2351 $^{-7}$	.8881 $^{-3}$	74.99	.8220 $^{-7}$	1102 $^{+4}$	2.4484018	126.64	.7639	.3781	6562	5.995	1095	.1512 $^{-6}$	.1381 $^{-3}$
76.00	.1903 $^{-10}$	.2200 $^{-7}$	.8649 $^{-3}$	75.99	.7693 $^{-7}$	1177 $^{+4}$	2.4484302	126.69	.7539	.3781	6739	5.995	1124	.1415 $^{-6}$	.1345 $^{-3}$
77.00	.1737 $^{-10}$	.2061 $^{-7}$	.8426 $^{-3}$	76.99	.7207 $^{-7}$	1256 $^{+4}$	2.4484576	126.74	.7441	.3781	6917	5.995	1154	.1326 $^{-6}$	.1310 $^{-3}$
78.00	.1587 $^{-10}$	.1932 $^{-7}$	.8212 $^{-3}$	77.99	.6757 $^{-7}$	1340 $^{+4}$	2.4484838	126.78	.7345	.3781	7098	5.995	1184	.1243 $^{-6}$	.1276 $^{-3}$
79.00	.1451 $^{-10}$	.1813 $^{-7}$	.8005 $^{-3}$	78.99	.6341 $^{-7}$	1428 $^{+4}$	2.4485091	126.83	.7253	.3781	7281	5.995	1215	.1166 $^{-6}$	.1244 $^{-3}$
80.00	.1329 $^{-10}$	.1703 $^{-7}$	.7806 $^{-3}$	79.99	.5954 $^{-7}$	1521 $^{+4}$	2.4485335	126.88	.7162	.3781	7467	5.995	1245	.1095 $^{-6}$	.1214 $^{-3}$
81.00	.1219 $^{-10}$	.1600 $^{-7}$	.7615 $^{-3}$	80.99	.5595 $^{-7}$	1618 $^{+4}$	2.4485569	126.92	.7074	.3781	7654	5.995	1277	.1030 $^{-6}$	.1184 $^{-3}$
82.00	.1118 $^{-10}$	.1505 $^{-7}$	.7431 $^{-3}$	81.99	.5264 $^{-7}$	1720 $^{+4}$	2.4485795	126.96	.6987	.3781	7845	5.995	1308	.9682 $^{-7}$	.1155 $^{-3}$
83.00	.1027 $^{-10}$	.1417 $^{-7}$	.7253 $^{-3}$	82.99	.4954 $^{-7}$	1828 $^{+4}$	2.4486013	127.00	.6903	.3781	8037	5.995	1341	.9113 $^{-7}$	.1127 $^{-3}$
84.00	.9448 $^{-11}$	.1334 $^{-7}$	.7081 $^{-3}$	83.99	.4667 $^{-7}$	1940 $^{+4}$	2.4486223	127.05	.6821	.3781	8232	5.996	1373	.8585 $^{-7}$	.1101 $^{-3}$
85.00	.8697 $^{-11}$	.1258 $^{-7}$	.6916 $^{-3}$	84.99	.4393 $^{-7}$	2059 $^{+4}$	2.4486426	127.09	.6741	.3781	8429	5.995	1406	.8092 $^{-7}$	.1075 $^{-3}$
86.00	.8014 $^{-11}$	.1186 $^{-7}$	.6756 $^{-3}$	85.99	.4149 $^{-7}$	2182 $^{+4}$	2.4486622	127.12	.6662	.3781	8629	5.996	1439	.7632 $^{-7}$	.1050 $^{-3}$
87.00	.7391 $^{-11}$	.1120 $^{-7}$	.6602 $^{-3}$	86.99	.3916 $^{-7}$	2312 $^{+4}$	2.4486811	127.16	.6586	.3781	8830	5.996	1473	.7204 $^{-7}$	.1026 $^{-3}$
88.00	.6823 $^{-11}$	.1058 $^{-7}$	.6452 $^{-3}$	87.99	.3699 $^{-7}$	2448 $^{+4}$	2.4486994	127.20	.6511	.3781	9035	5.995	1507	.6804 $^{-7}$	.1003 $^{-3}$
89.00	.6305 $^{-11}$	.9995 $^{-8}$	.6308 $^{-3}$	88.99	.3495 $^{-7}$	2590 $^{+4}$	2.4487170	127.24	.6438	.3781	9241	5.996	1541	.6431 $^{-7}$	.9805 $^{-4}$
90.00	.5831 $^{-11}$	.9452 $^{-8}$	.6169 $^{-3}$	89.99	.3305 $^{-7}$	2739 $^{+4}$	2.4487341	127.27	.6366	.3781	9450	5.996	1576	.6032 $^{-7}$	.9588 $^{-4}$
91.00	.5397 $^{-11}$	.8944 $^{-8}$	.6034 $^{-3}$	90.99	.3129 $^{-7}$	2894 $^{+4}$	2.4487506	127.31	.6296	.3781	9661	5.996	1611	.5755 $^{-7}$	.9378 $^{-4}$
92.00	.5000 $^{-11}$	.8469 $^{-8}$	.5904 $^{-3}$	91.99	.2962 $^{-7}$	3057 $^{+4}$	2.4487666	127.34	.6228	.3781	9875	5.997	1647	.5450 $^{-7}$	.9175 $^{-4}$
93.00	.4636 $^{-11}$	.8023 $^{-8}$	.5778 $^{-3}$	92.99	.2807 $^{-7}$	3226 $^{+4}$	2.4487820	127.38	.6160	.3781	1009 $^{+1}$	5.997	1683	.5163 $^{-7}$	.8978 $^{-4}$
94.00	.4302 $^{-11}$	.7606 $^{-8}$	.5656 $^{-3}$	93.99	.2661 $^{-7}$	3403 $^{+4}$	2.4487970	127.41	.6095	.3781	1031 $^{+1}$	5.997	1719	.4894 $^{-7}$	.8790 $^{-4}$
95.00	.3995 $^{-11}$	.7214 $^{-8}$	.5537 $^{-3}$	94.99	.2524 $^{-7}$	3588 $^{+4}$	2.4488115	127.44	.6031	.3781	1053 $^{+1}$	5.997	1756	.4642 $^{-7}$	.8605 $^{-4}$
96.00	.3712 $^{-11}$	.6846 $^{-8}$	.5422 $^{-3}$	95.99	.2395 $^{-7}$	3781 $^{+4}$	2.4488255	127.47	.5968	.3781	1075 $^{+1}$	5.997	1793	.4405 $^{-7}$	.8427 $^{-4}$
97.00	.3453 $^{-11}$	.6501 $^{-8}$	.5311 $^{-3}$	96.99	.2274 $^{-7}$	3982 $^{+4}$	2.4488392	127.50	.5907	.3781	1098 $^{+1}$	5.997	1831	.4183 $^{-7}$	.8254 $^{-4}$
98.00	.3214 $^{-11}$	.6176 $^{-8}$	.5204 $^{-3}$	97.99	.2161 $^{-7}$	4191 $^{+4}$	2.4488524	127.53	.5847	.3781	1121 $^{+1}$	5.997	1869	.3974 $^{-7}$	.8087 $^{-4}$
99.00	.2993 $^{-11}$	.5870 $^{-8}$	.5099 $^{-3}$	98.99	.2054 $^{-7}$	4410 $^{+4}$	2.4488652	127.56	.5787	.3781	1143 $^{+1}$	5.997	1907	.3778 $^{-7}$	.7923 $^{-4}$
100.00	.2790 $^{-11}$	.5583 $^{-8}$	.4998 $^{-3}$	100.00	.1953 $^{-7}$	4637 $^{+4}$	2.4488776	127.59	.5730	.3781	1167 $^{+1}$	5.997	1945	.3593 $^{-7}$	.7765 $^{-4}$

NOTATIONS FOR TABLES I AND II

- M or M_1 — local Mach number or Mach number upstream of a normal shock wave
- $\frac{p}{p_t}$ — ratio of static pressure to total pressure
- $\frac{\rho}{\rho_t}$ — ratio of static density to total density
- $\frac{T}{T_t}$ — ratio of static temperature to total temperature
- β — $\sqrt{M^2-1}$
- $\frac{q}{p_t}$ — ratio of dynamic pressure, $\frac{1}{2}\rho V^2$, to total pressure
- $\frac{A}{A_*}$ — ratio of local cross-sectional area of an isentropic stream tube to cross-sectional area at the point where $M=1$
- $\frac{V}{a_*}$ — ratio of local speed to speed of sound at the point where $M=1$
- ν — Prandtl-Meyer angle (angle through which a supersonic stream is turned to expand from $M=1$ to $M>1$), deg
- μ — Mach angle, $\sin^{-1}\frac{1}{M}$, deg
- M_2 — Mach number downstream of a normal shock wave
- $\frac{p_2}{p_1}$ — static pressure ratio across a normal shock wave
- $\frac{\rho_2}{\rho_1}$ — static density ratio across a normal shock wave
- $\frac{T_2}{T_1}$ — static temperature ratio across a normal shock wave
- $\frac{p_{t_2}}{p_{t_1}}$ — total pressure ratio across a normal shock wave
- $\frac{p_1}{p_{t_2}}$ — ratio of static pressure upstream of a normal shock wave to total pressure downstream

CHARTS

The charts that follow present numerical values of certain physical quantities that are functions of two variables and hence are cumbersome to tabulate. These charts are designed to provide accuracy to three significant figures.

Charts 1 through 8 and chart 25 are for a perfect gas. The values presented in charts 1 through 4 and chart 25 were calculated for a ratio of specific heats of 7/5. The values presented in charts 5 through 8 were taken from references 6 and 14 and are for a ratio of specific heats of 1.405.

Charts 9 through 24 provide correction factors to account for the effects of caloric imperfections on the quantities tabulated in tables I and II and plotted in charts 2, 3, and 4.

On many charts, points corresponding to static temperatures of 5000° R and 100°R (−360° F) have been indicated. These temperatures represent very approximately the limits of validity of the charts. Exact limits cannot be stated simply as they depend on pressure as well as temperature. At temperatures near 5000° R dissociation effects, which were neglected in the calculations, can be significant at high altitudes though perhaps not at sea level. At temperatures less than about 100° R, air may condense at the pressures encountered in many wind tunnels.

On the Reynolds number chart (chart 25), points corresponding to a static temperature of 180° R (−280° F) also are indicated since this is the lowest temperature for which experimental viscosity data have been obtained. At temperatures much lower than −280° F, Sutherland's equation (A2) may significantly underestimate the true viscosity.

The contents of the charts are as follows:

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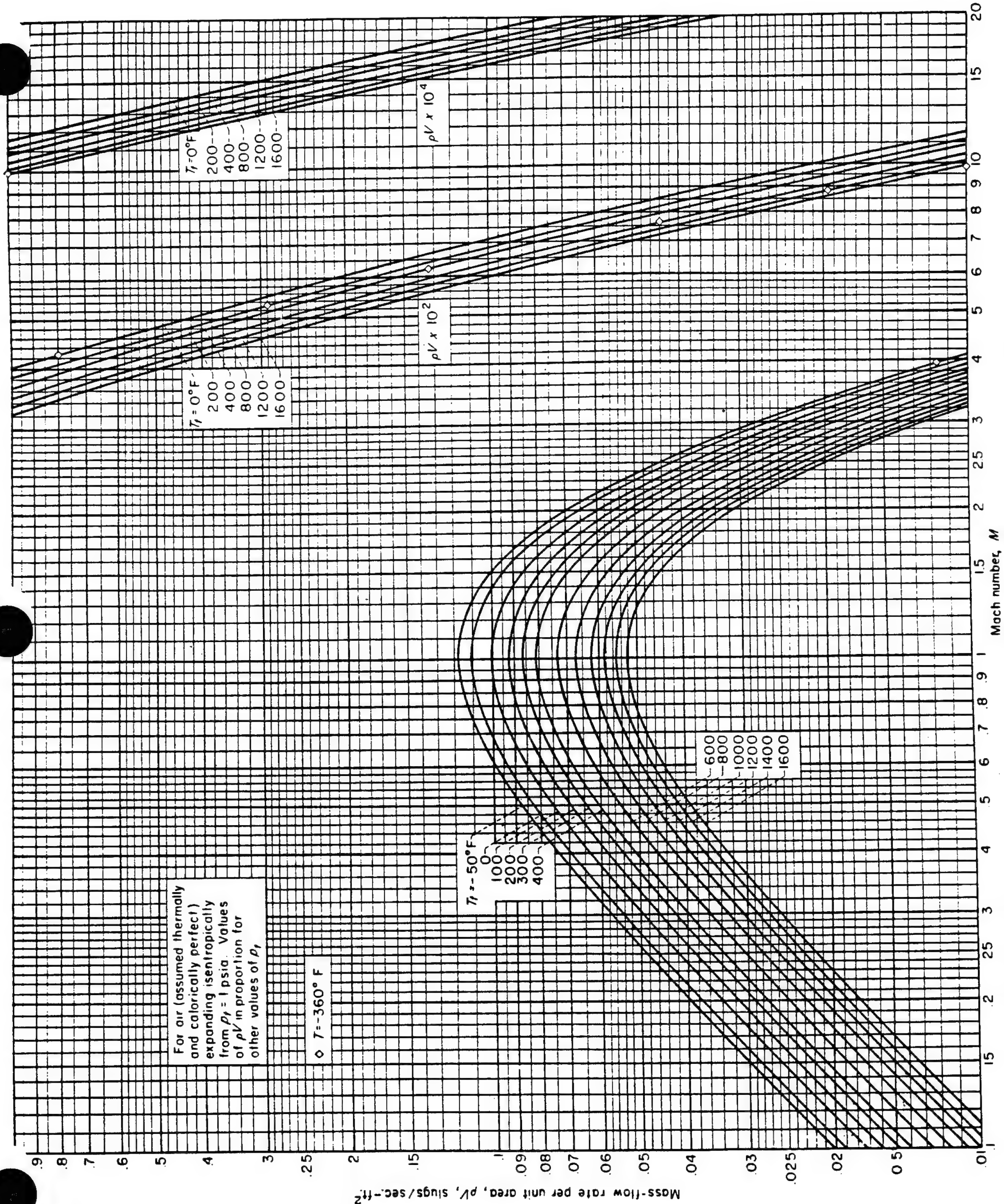


CHART 1.—Variation of mass-flow rate per unit area with Mach number for various total temperatures. Perfect gas, $\gamma = 7/5$.

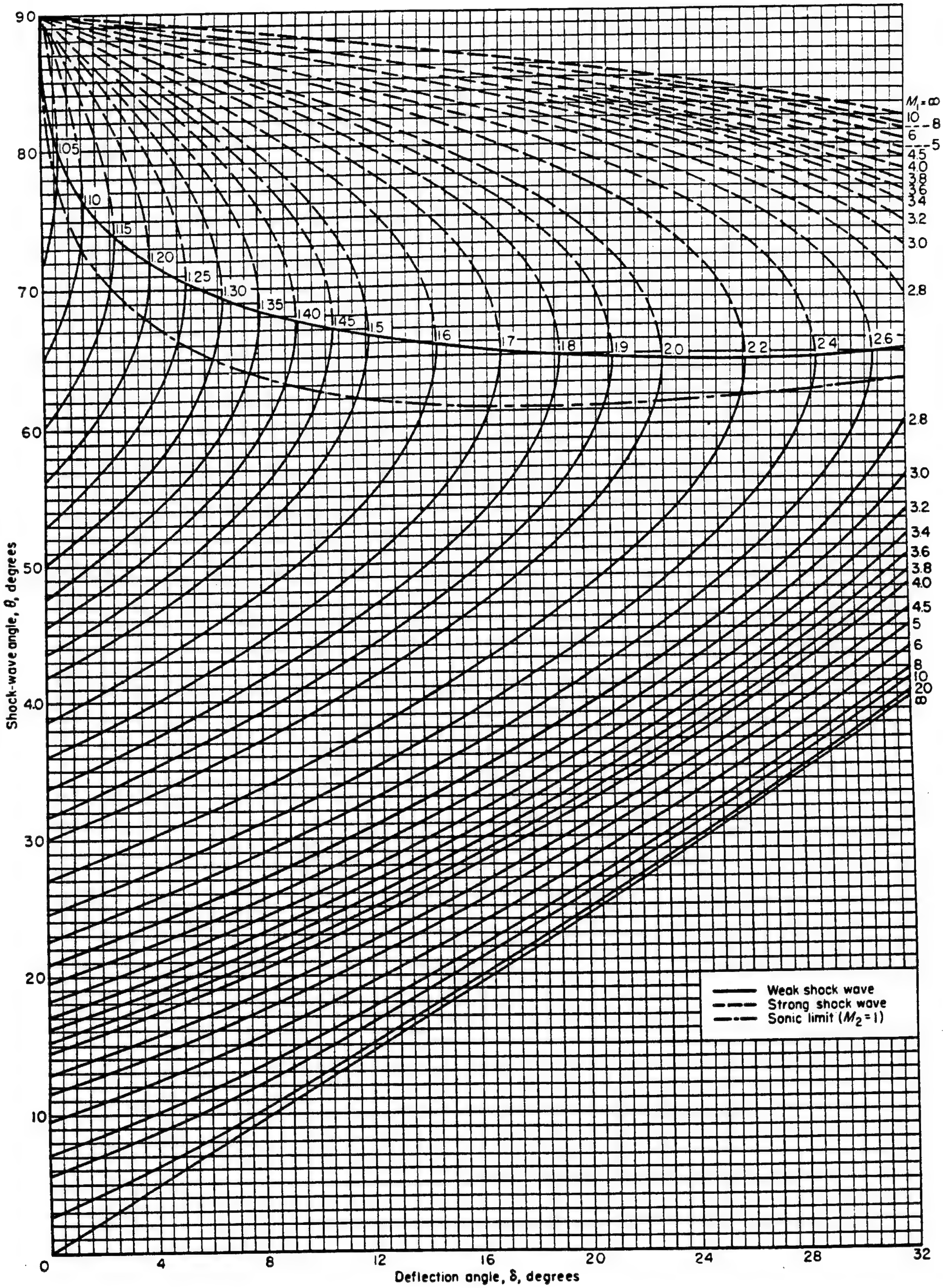


CHART 2.—Variation of shock-wave angle with flow-deflection angle for various upstream Mach numbers. Perfect gas, $\gamma = 7/5$.

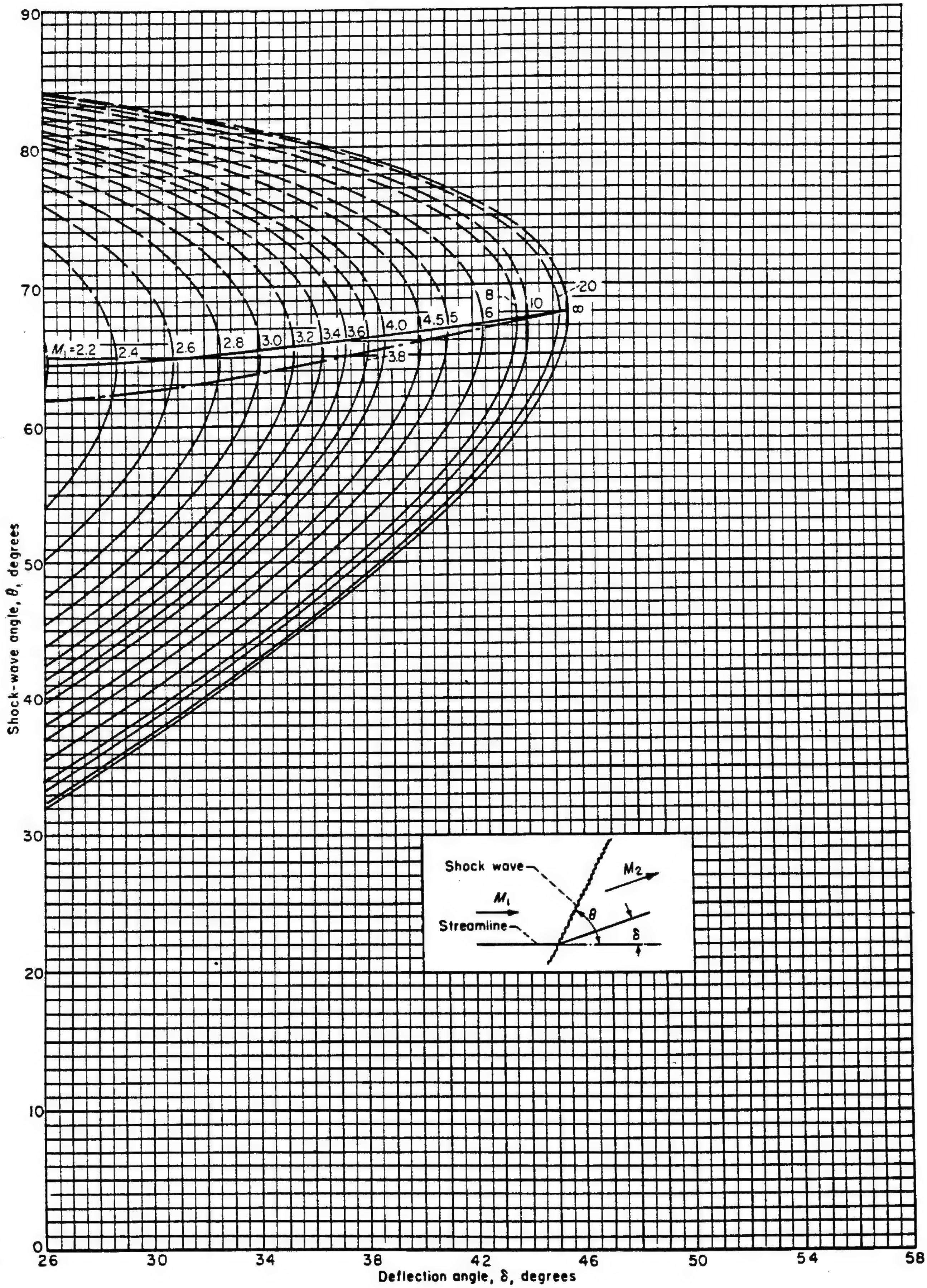


Chart 2.—Concluded

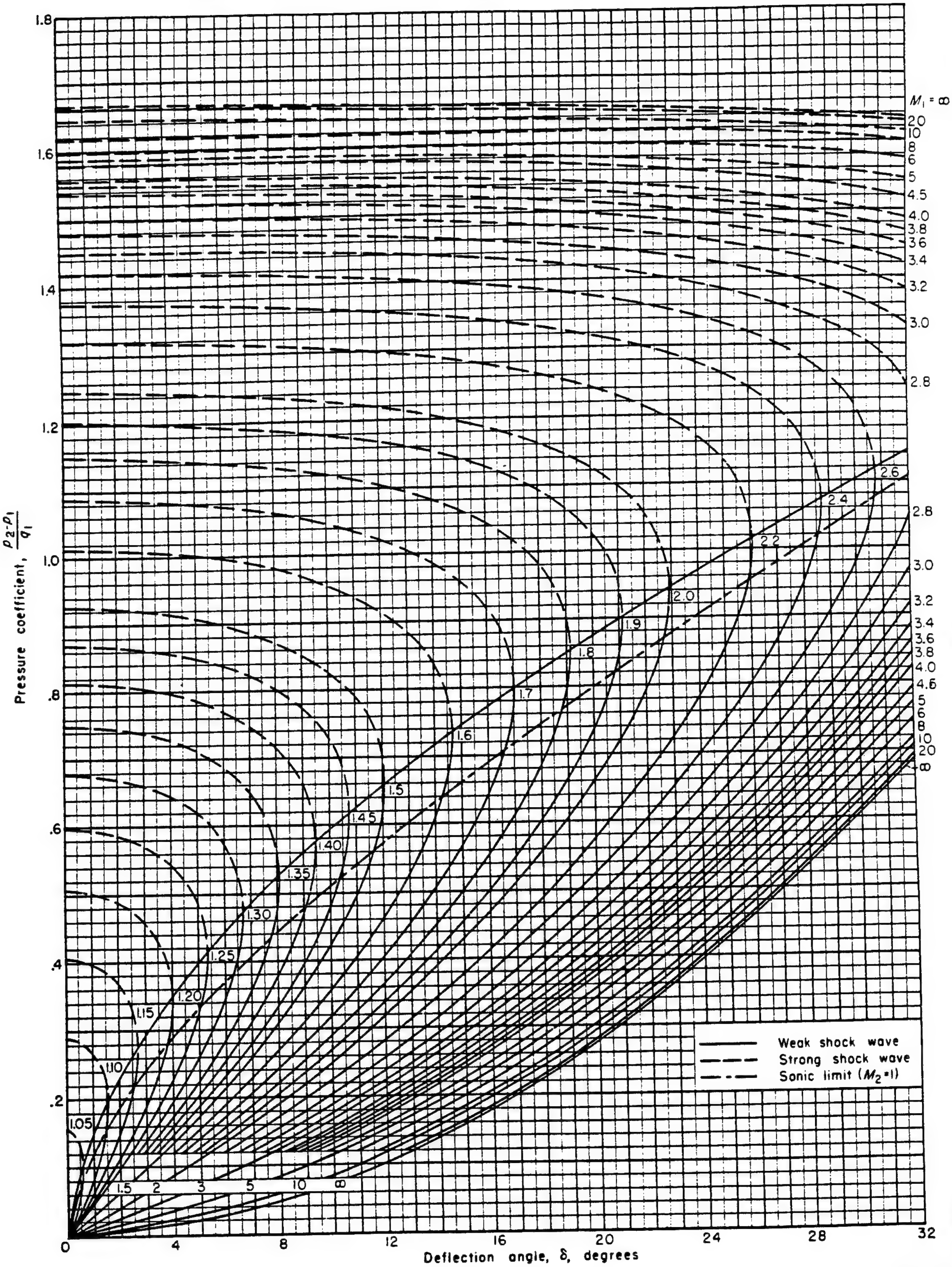


CHART 3.—Variation of pressure coefficient across shock waves with flow-deflection angle for various upstream Mach numbers. Perfect gas, γ

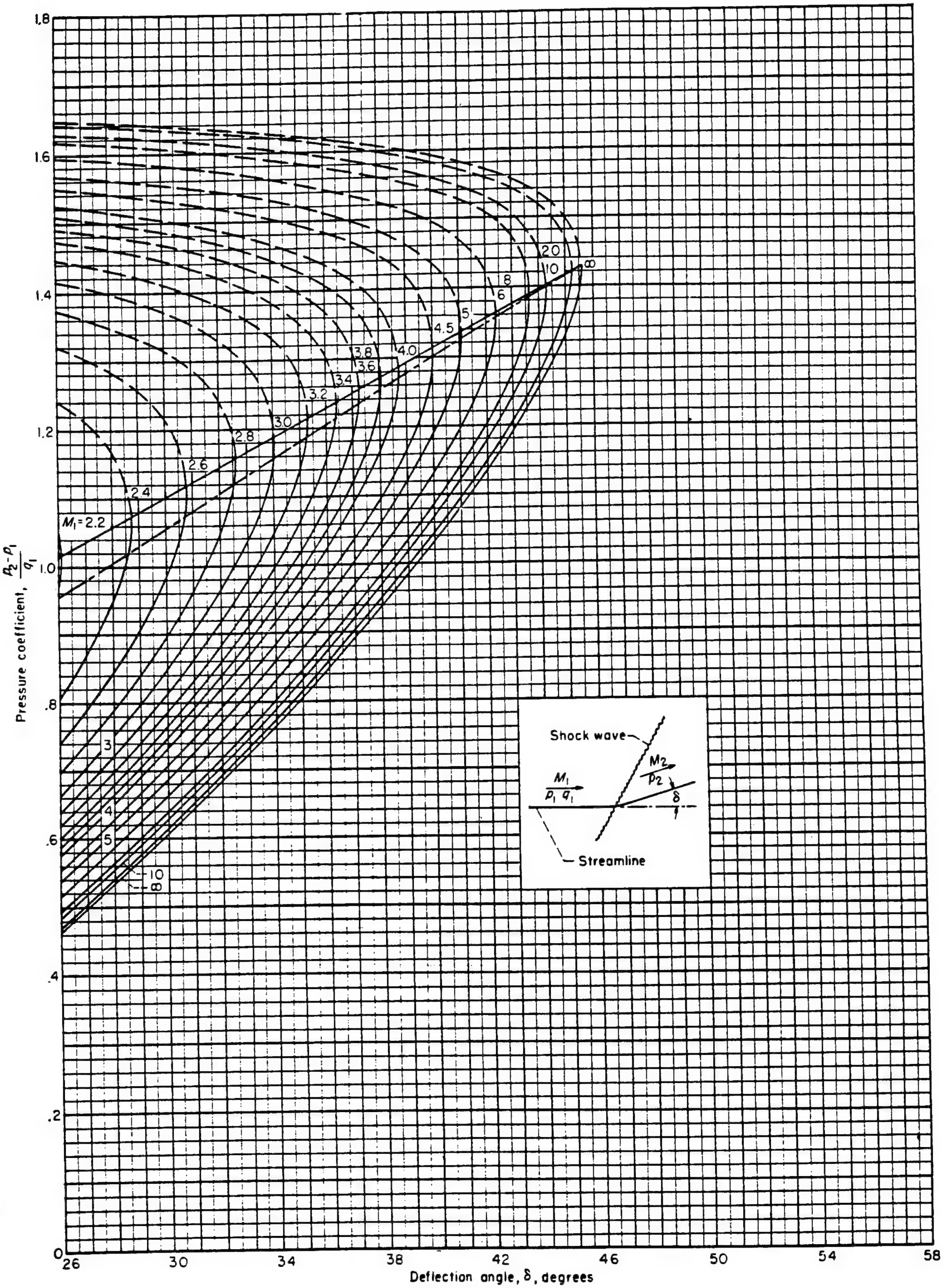


CHART 3.—Concluded

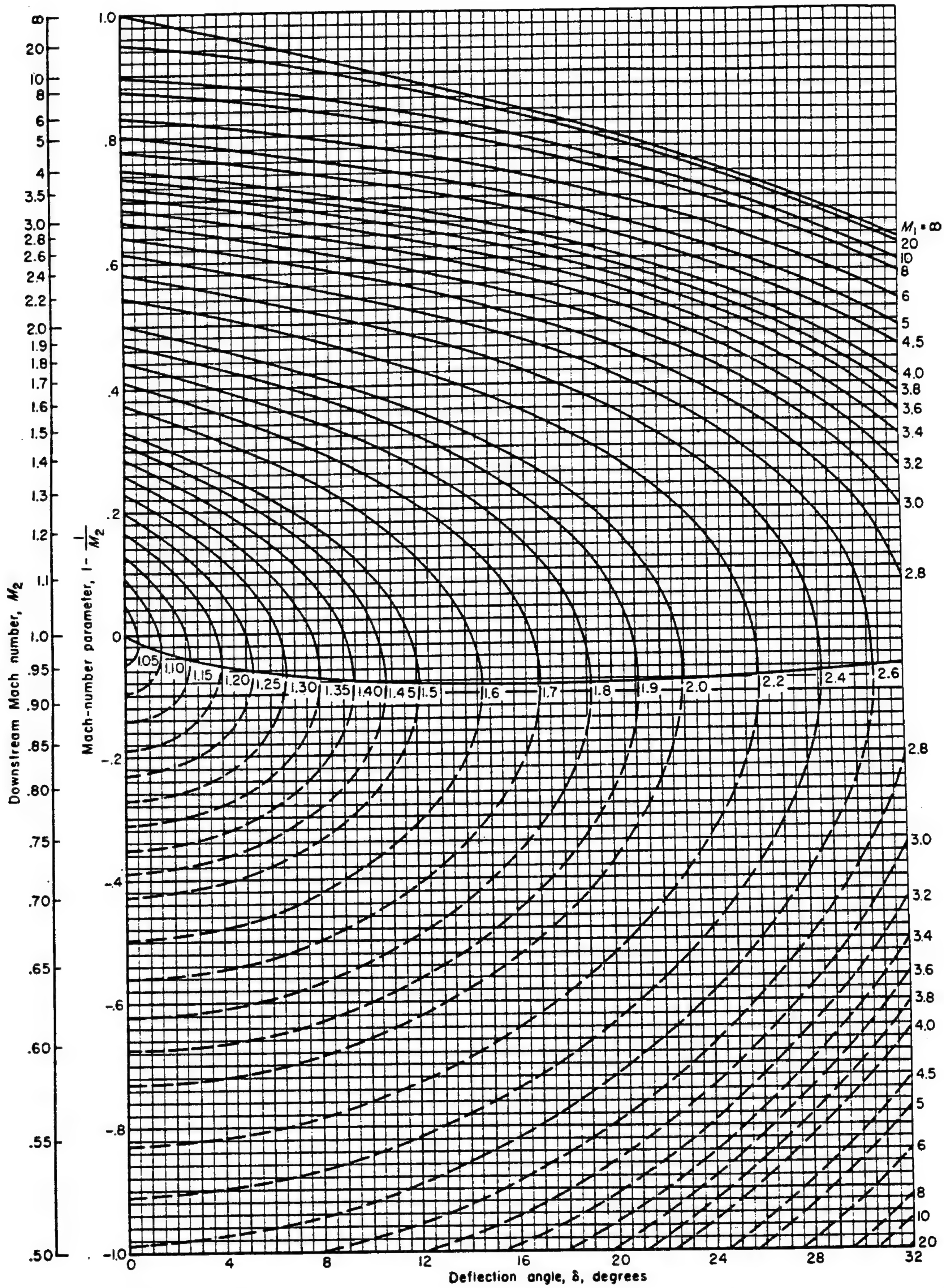


Chart 4.—Variation of Mach number downstream of a shock wave with flow-deflection angle for various upstream Mach numbers. Perfect g
$\gamma = 7/5$.

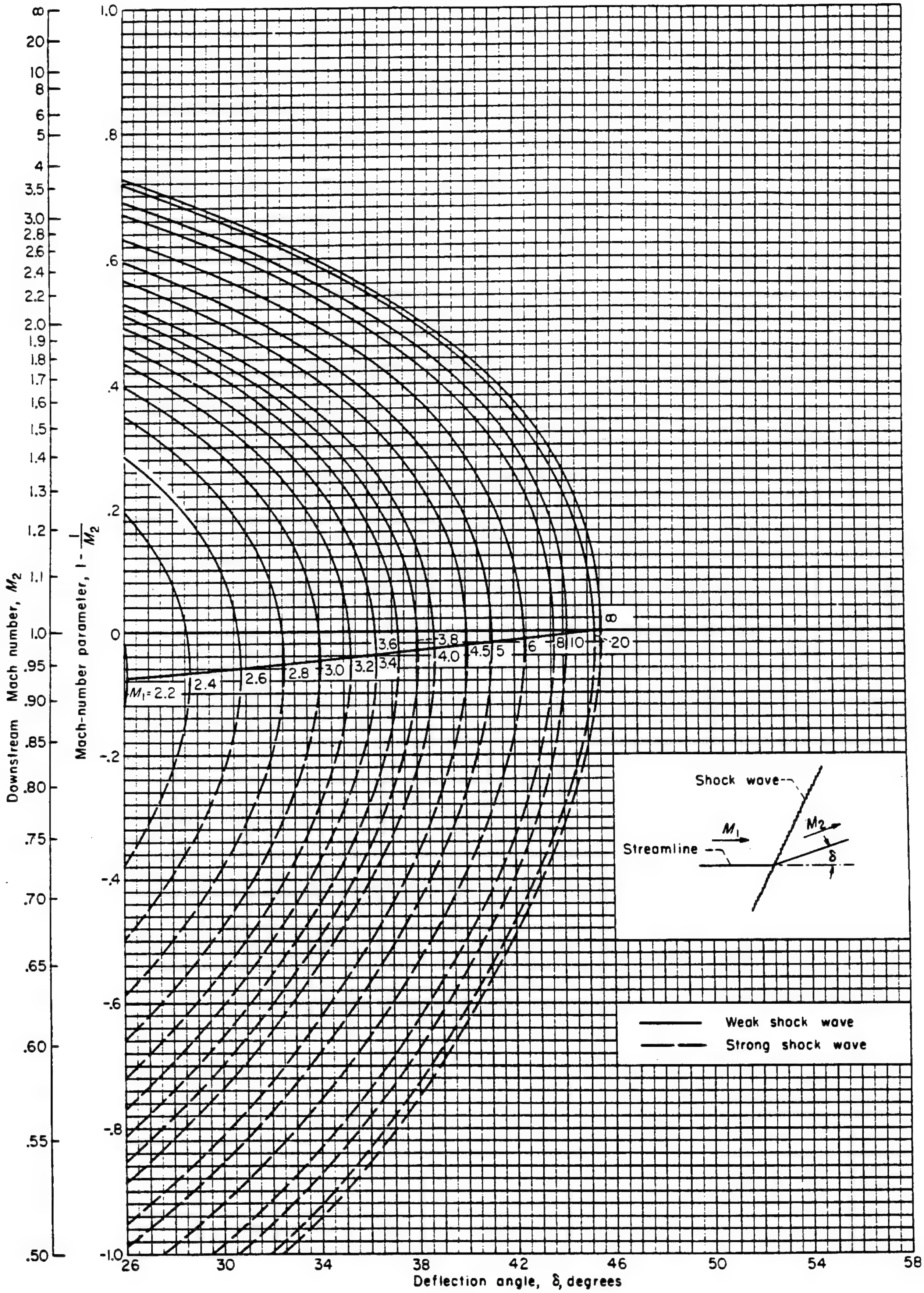


CHART 4.—Concluded

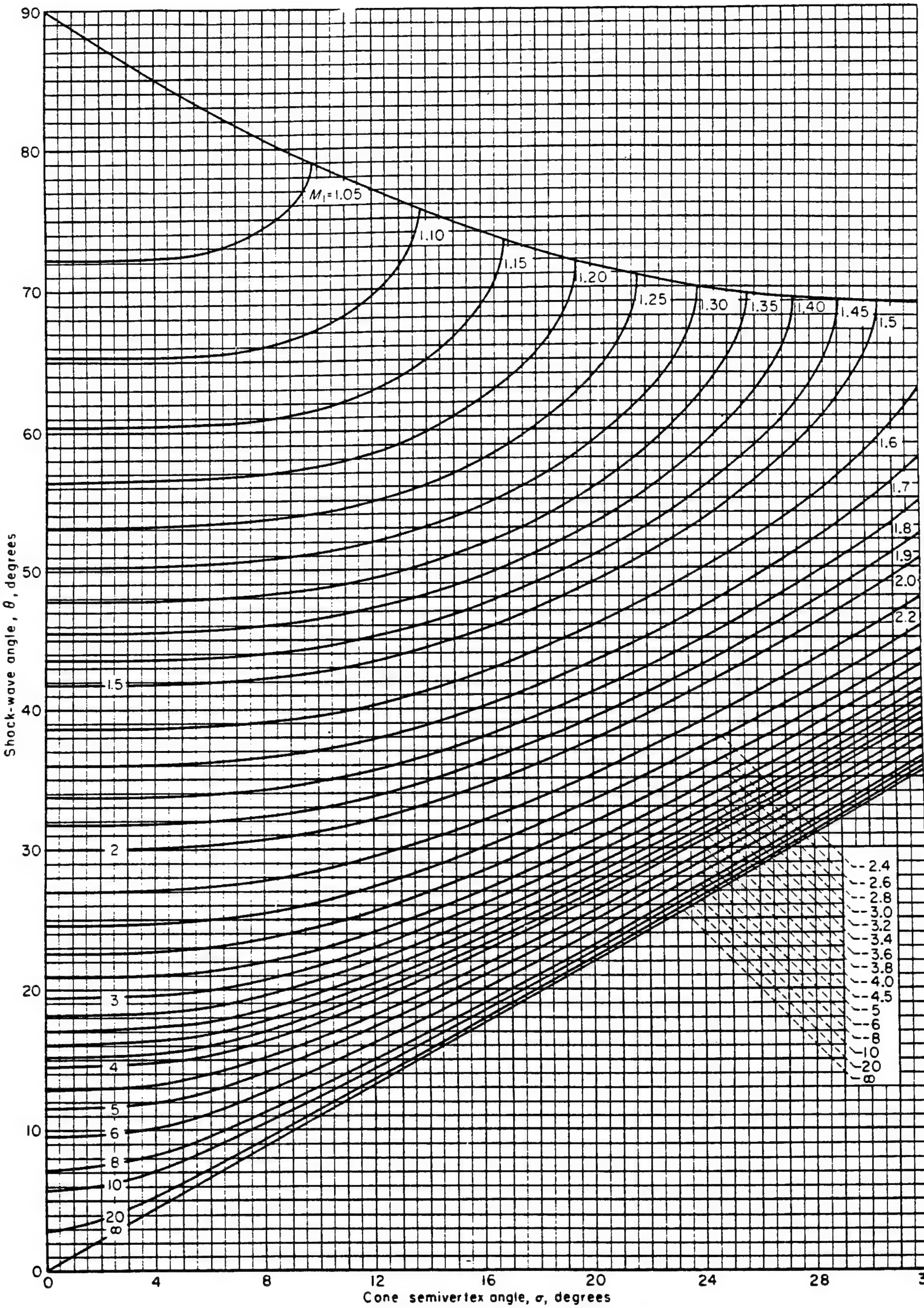


CHART 5.—Variation of shock-wave angle with cone semivertex angle for various upstream Mach numbers. Perfect gas, $\gamma=1.405$.

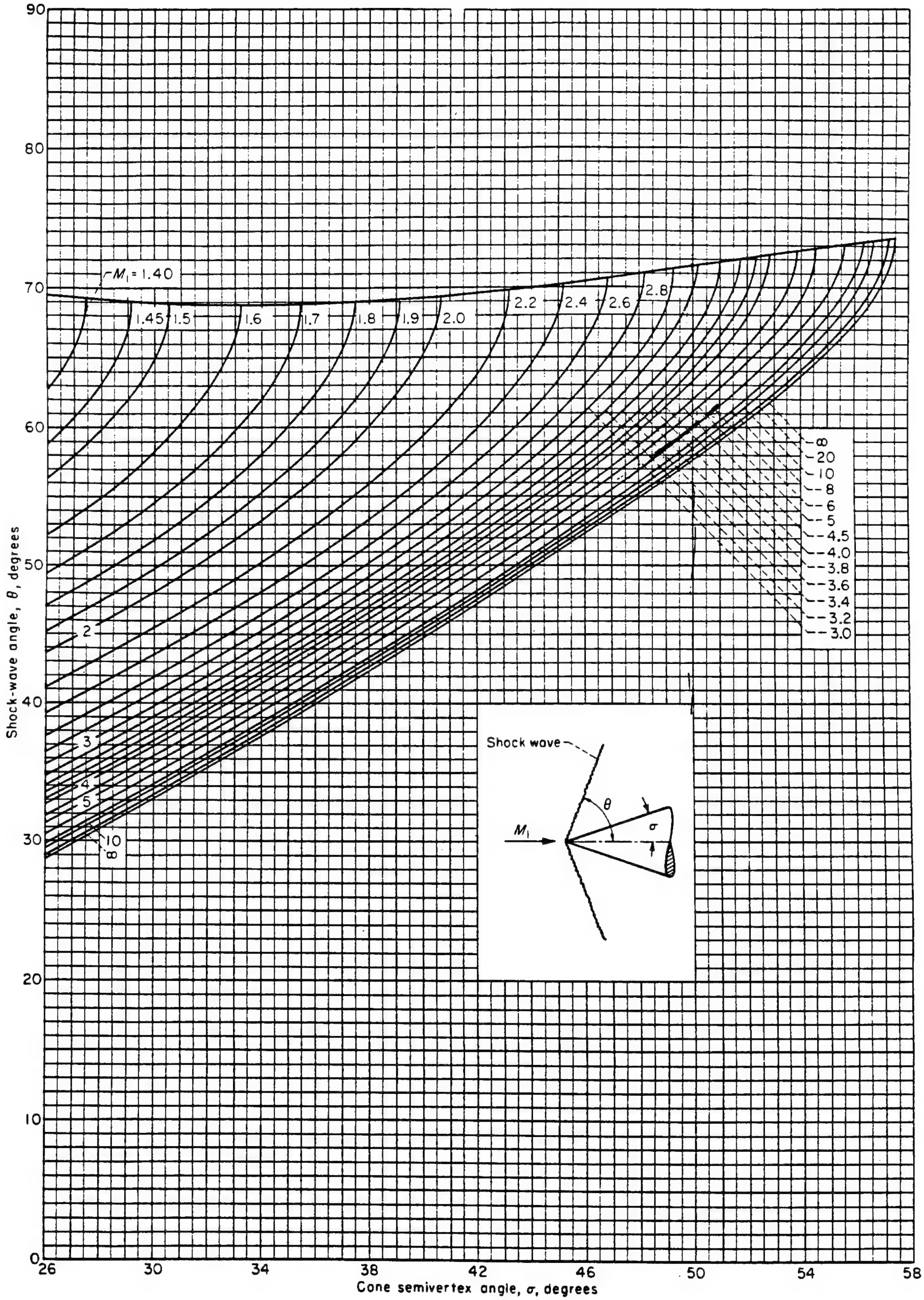


CHART 5.—Concluded

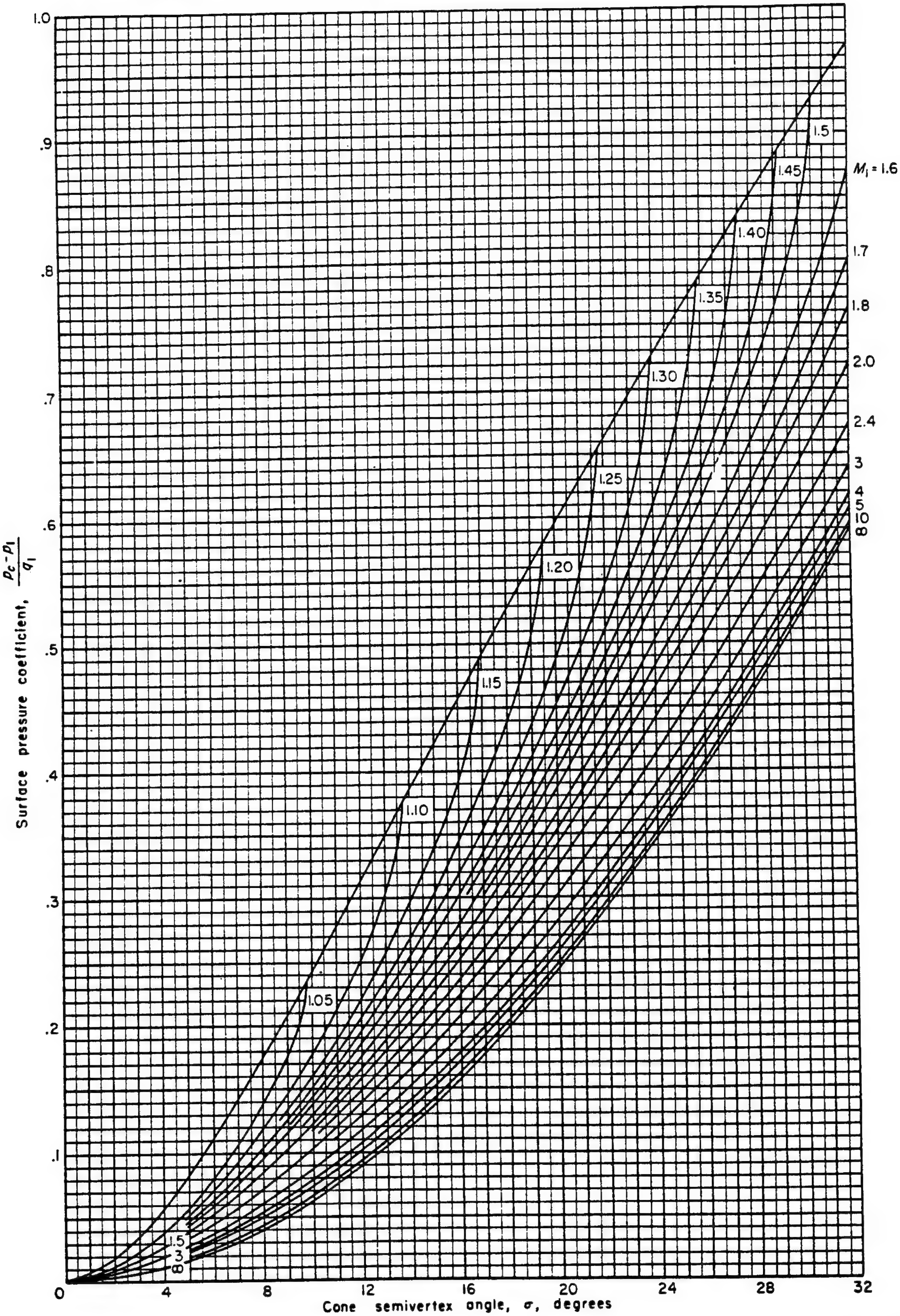


Chart 6.—Variation of surface pressure coefficient with cone semivertex angle for various upstream Mach numbers. Perfect gas, $\gamma = 1.405$.

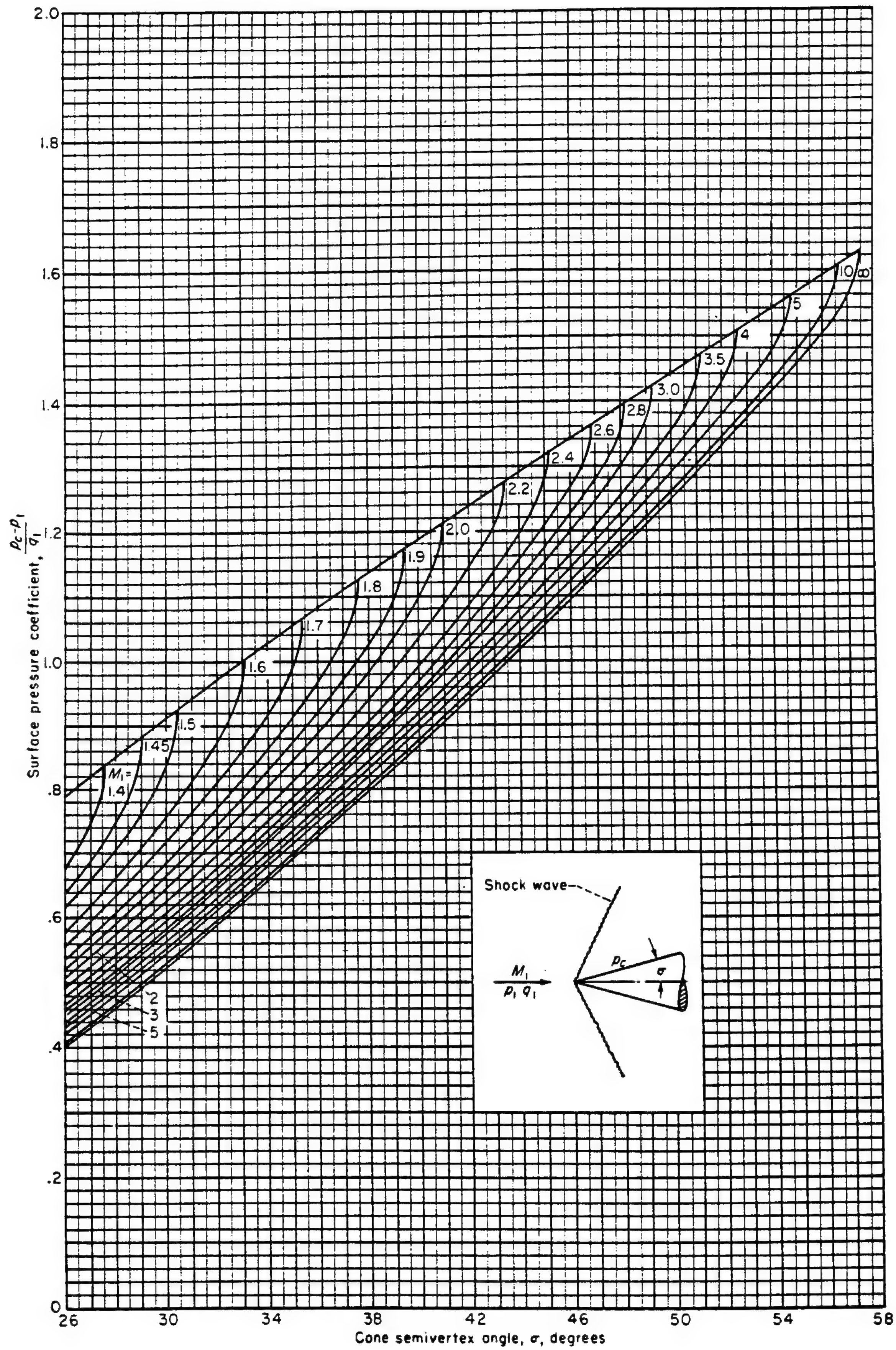


CHART 6.—Concluded

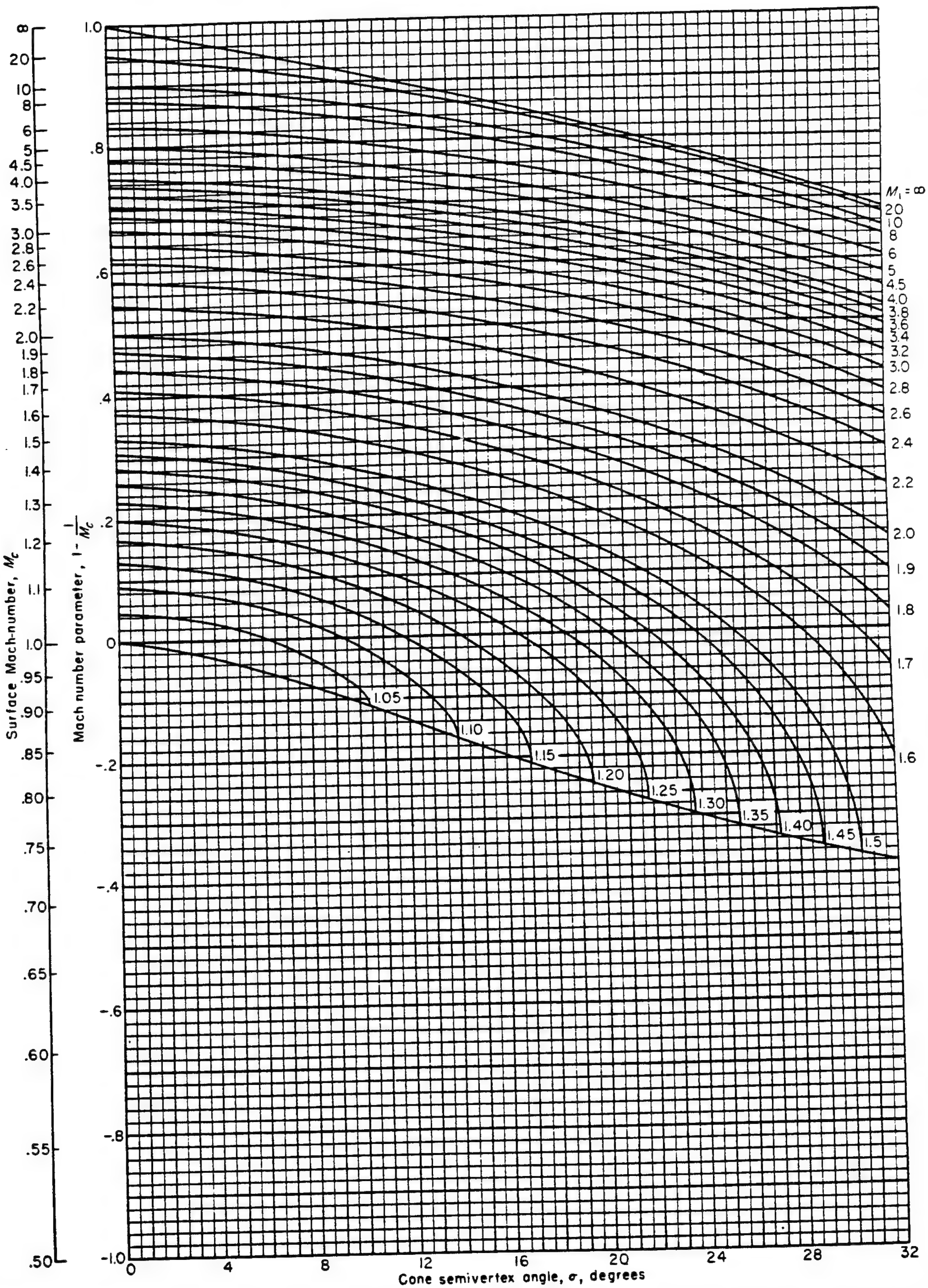


CHART 7.—Variation of Mach number at the surface of a cone with cone semivertex angle for various upstream Mach numbers. Perfect gas, $\gamma=1.405$.

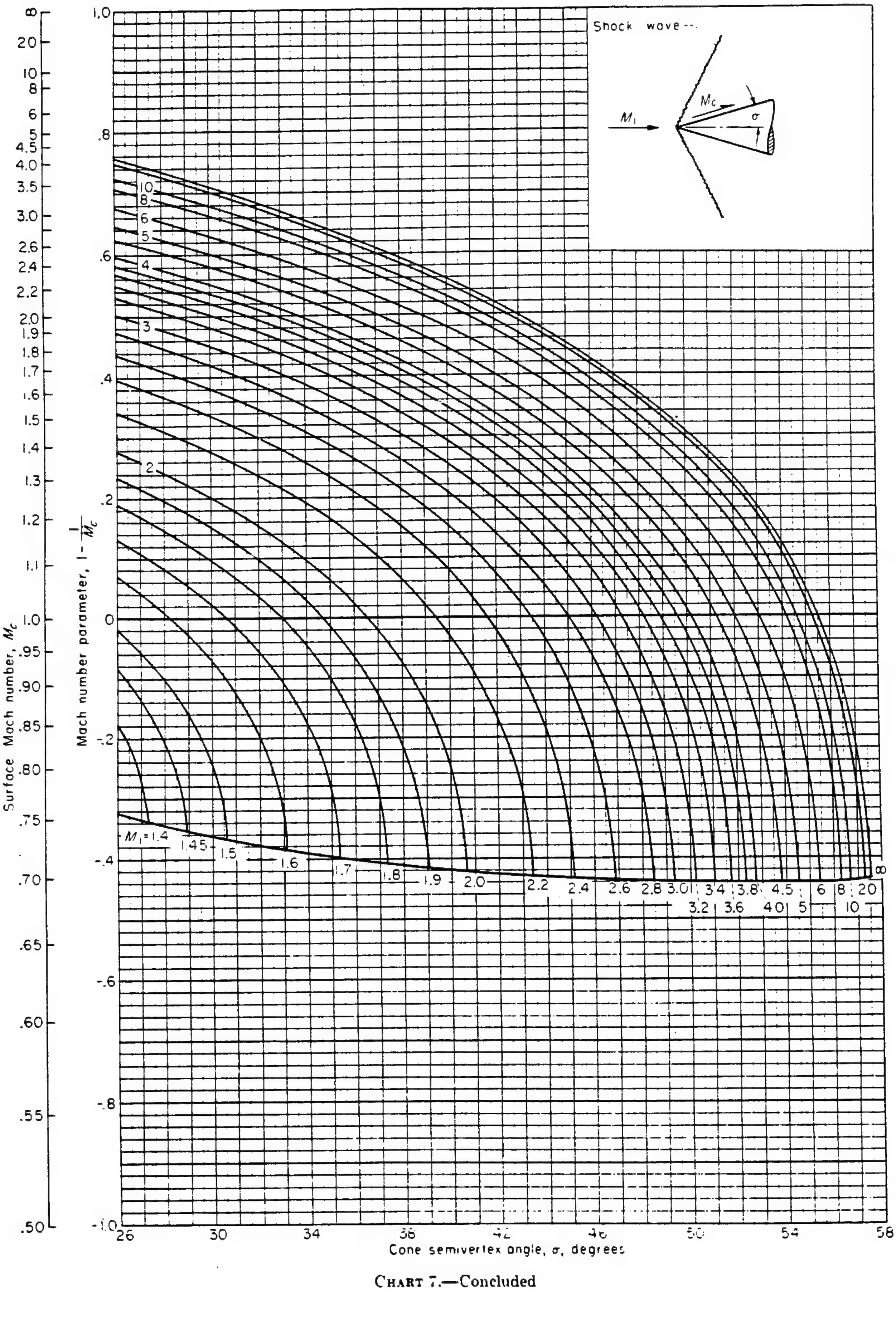


CHART 7.—Concluded

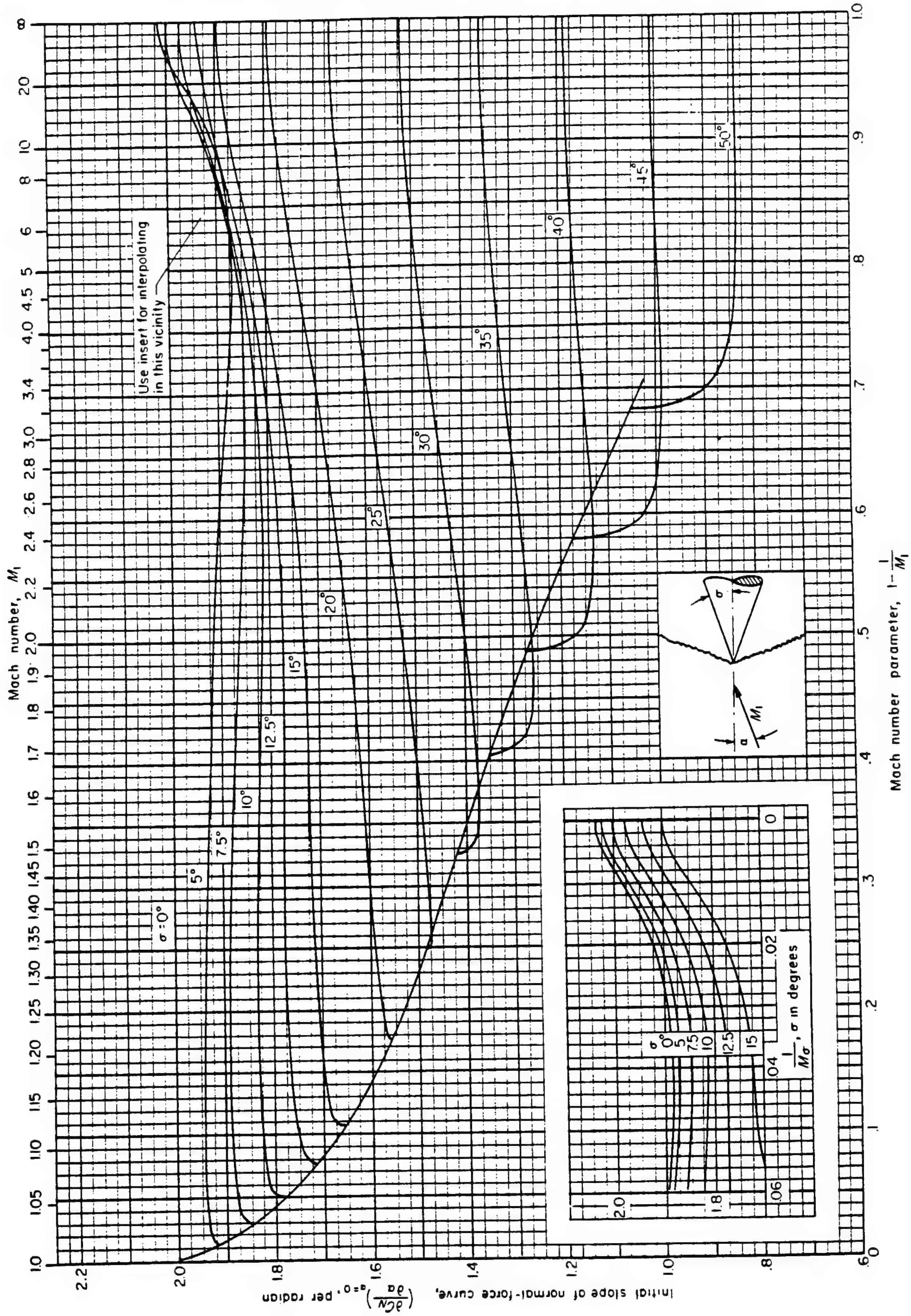


CHART 8.—Variation of the initial slope of the normal-force curve with upstream Mach number for various cone semivertex angles. Perfect gas, $\gamma = 1.405$.

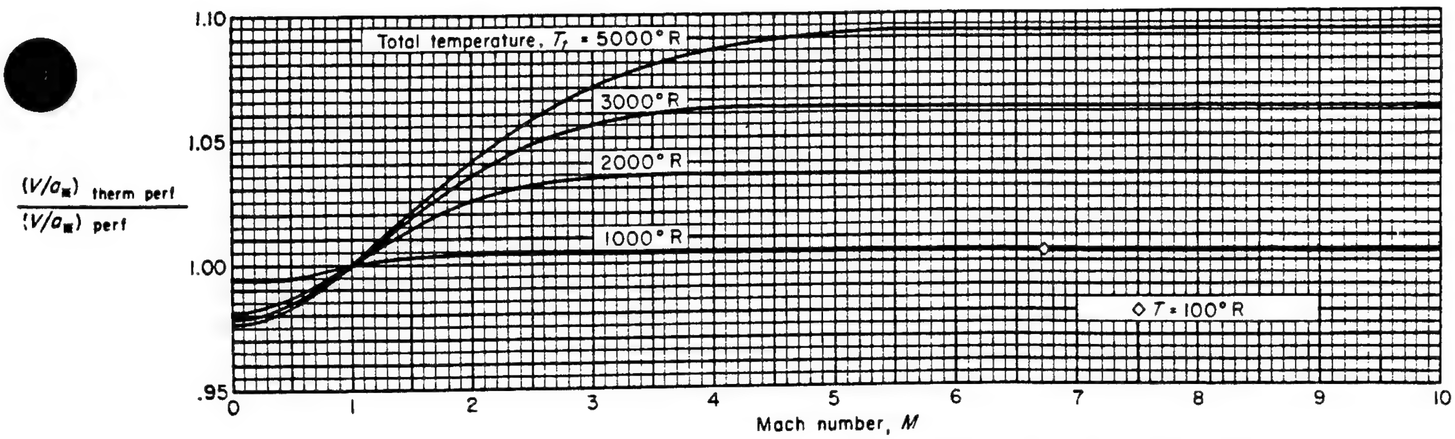


CHART 9.—Effect of caloric imperfections on the ratio of local speed to speed of sound at the point where $M=1$.

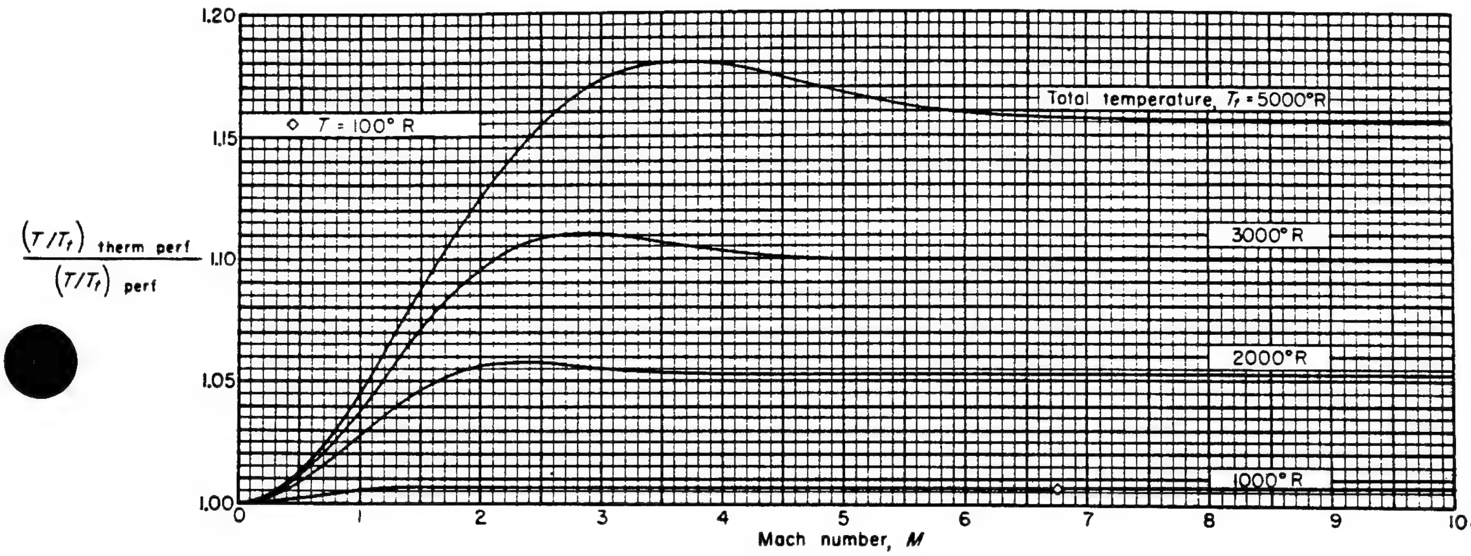


CHART 10.—Effect of caloric imperfections on the ratio of static temperature to total temperature.

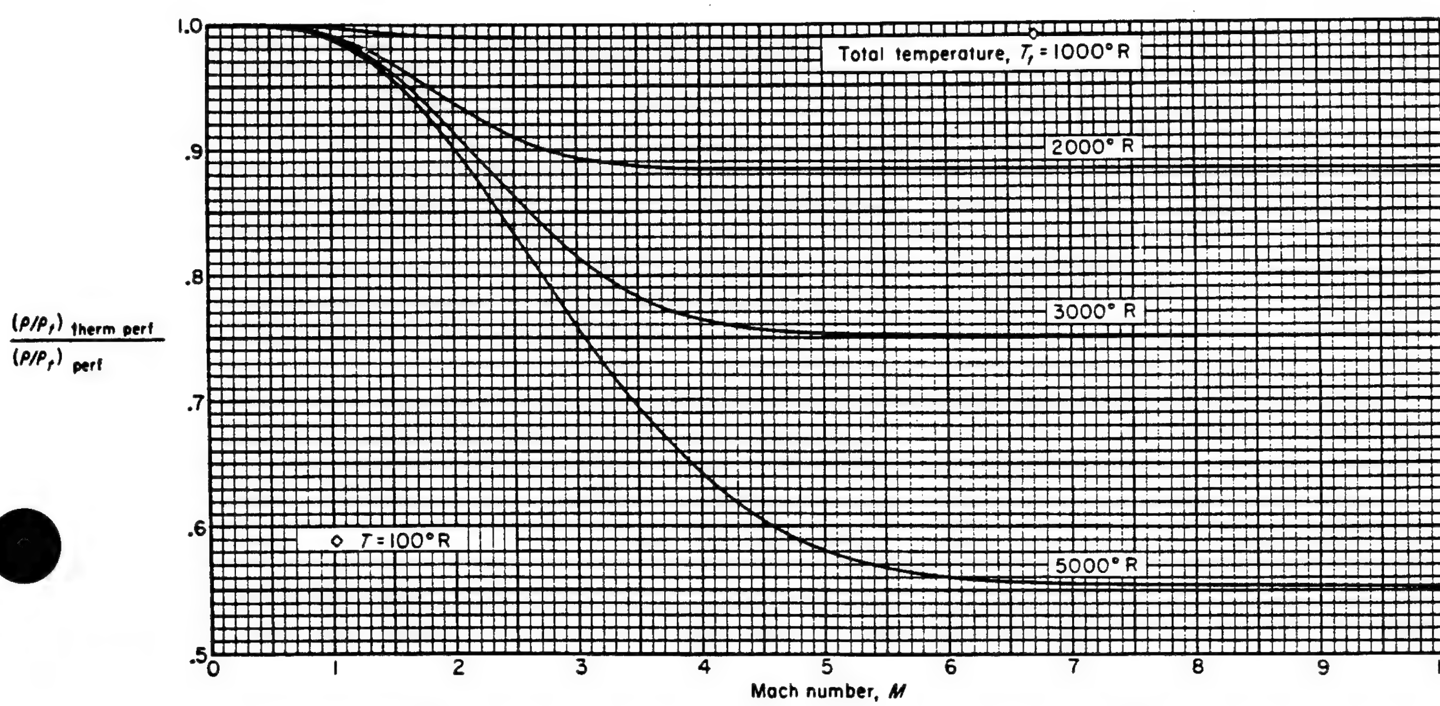


CHART 11.—Effect of caloric imperfections on the ratio of static density to total density.

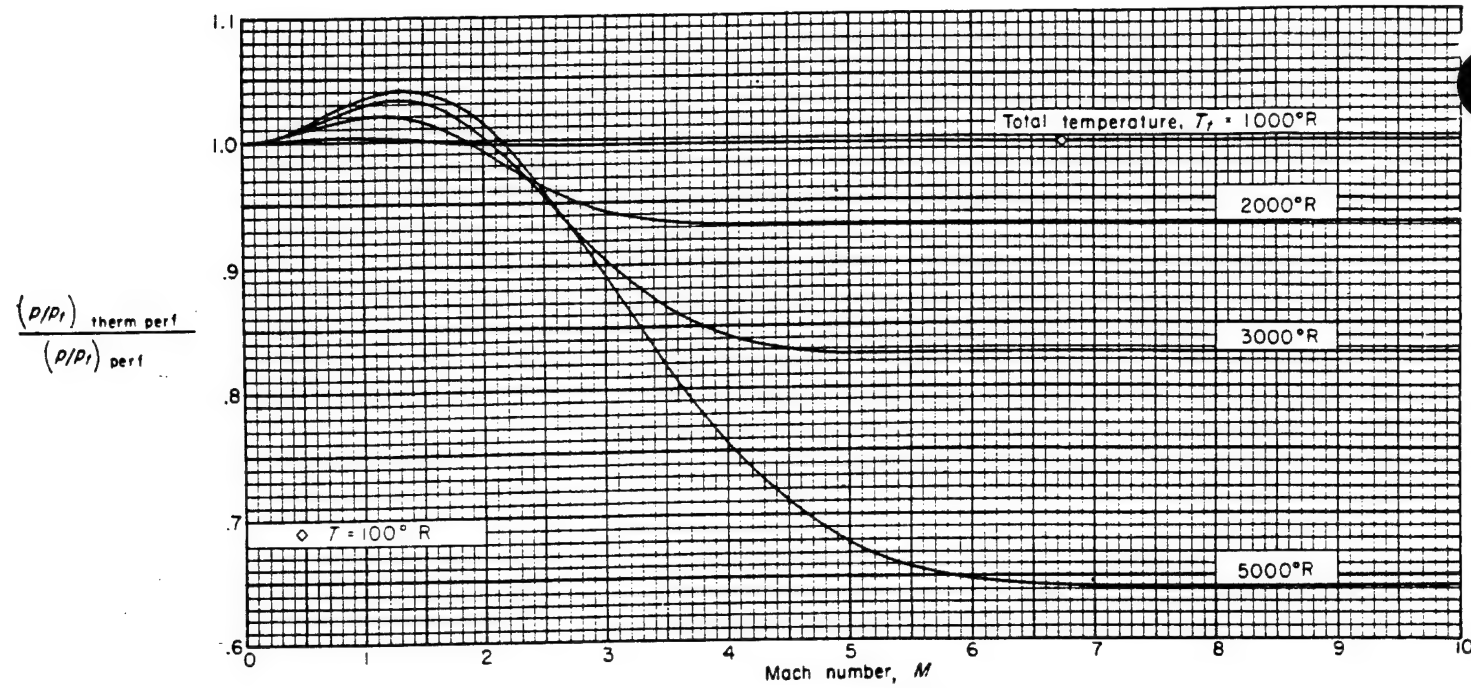


CHART 12.—Effect of caloric imperfections on the ratio of static pressure to total pressure.

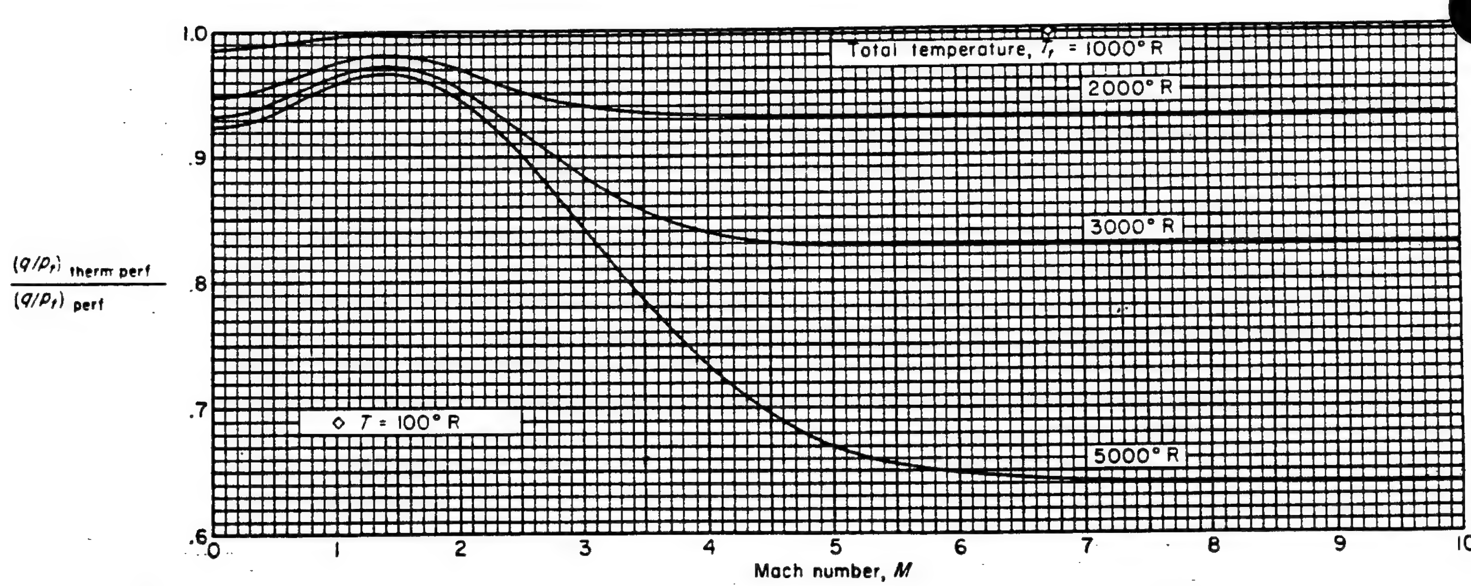


CHART 13.—Effect of caloric imperfections on the ratio of dynamic pressure to total pressure.

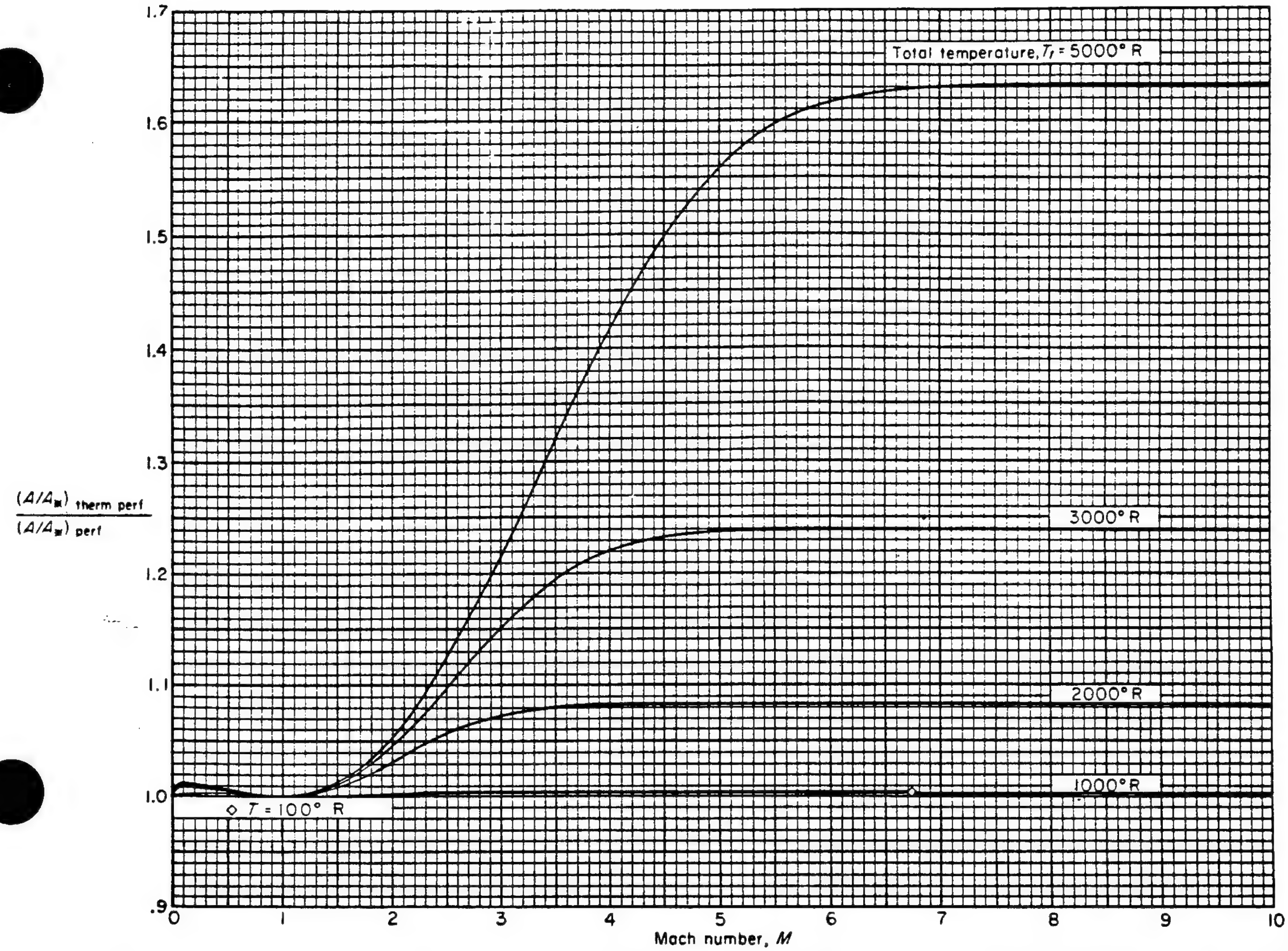


Chart 14.—Effect of caloric imperfections on the ratio of local cross-sectional area of a stream tube to the cross-sectional area at the point where $M=1$.

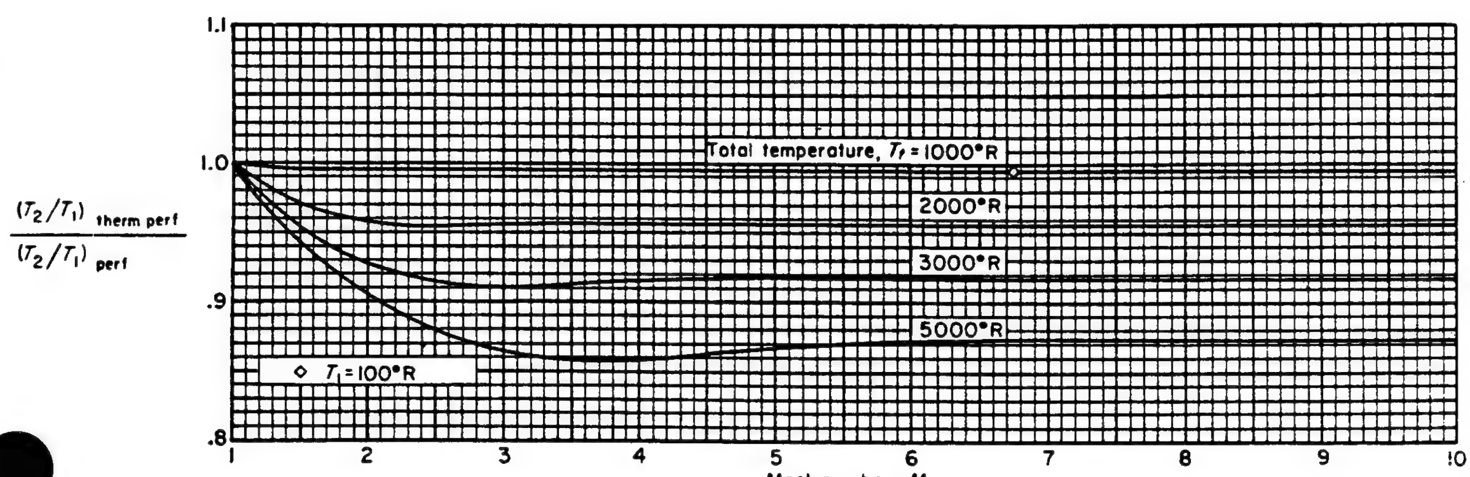


Chart 15.—Effect of caloric imperfections on the static-temperature ratio across a normal shock wave.

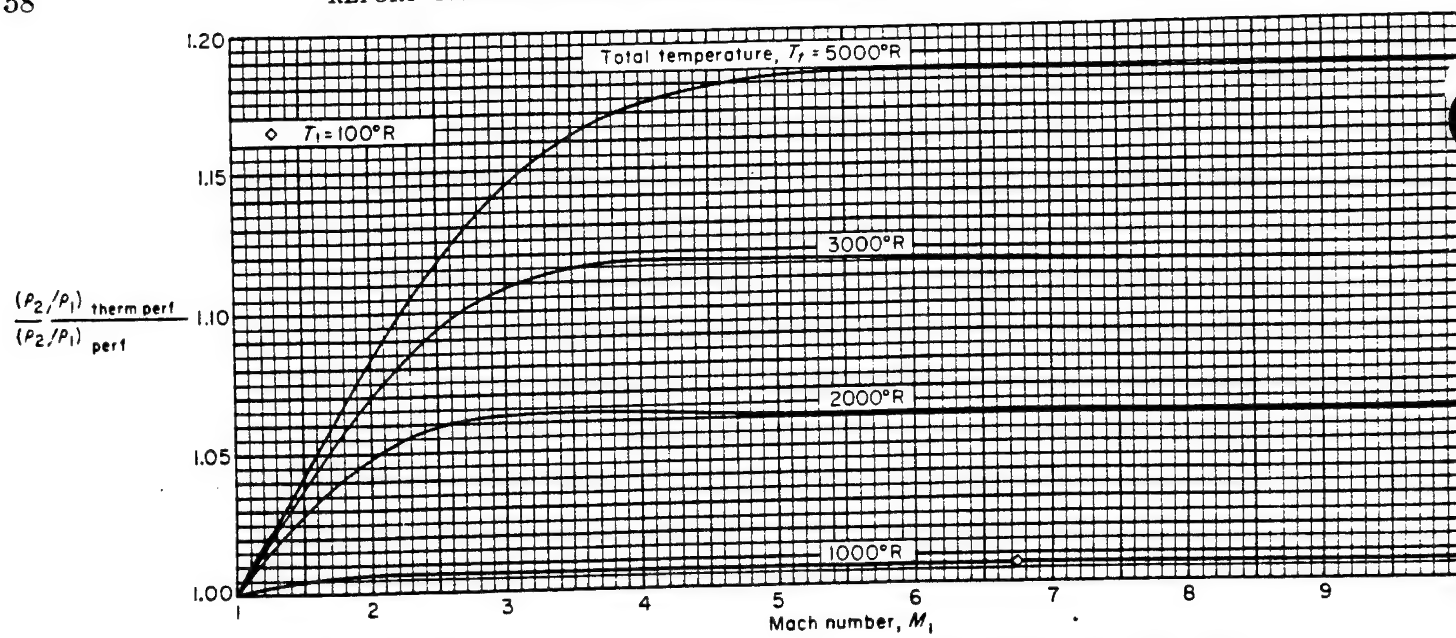


CHART 16.—Effect of caloric imperfections on the static-density ratio across a normal shock wave.

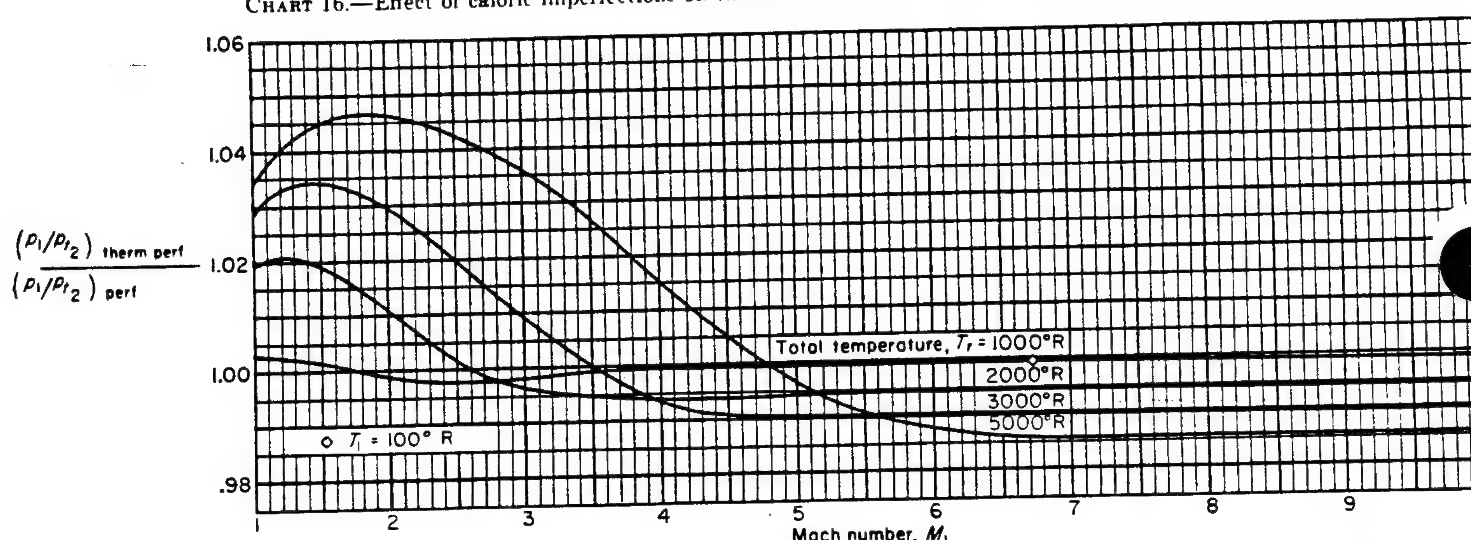


CHART 17.—Effect of caloric imperfections on the ratio of static pressure upstream of a normal shock wave to total pressure downstream.

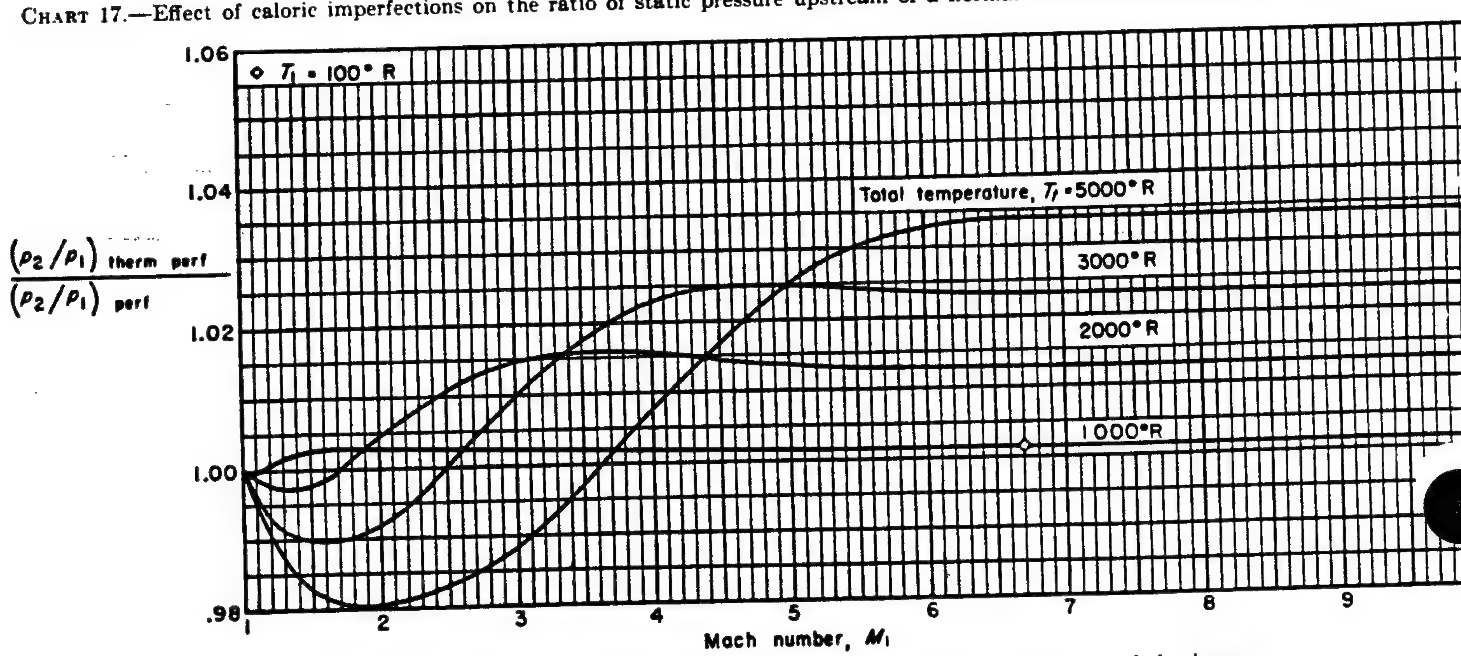


CHART 18.—Effect of caloric imperfections on the static-pressure ratio across a normal shock wave.

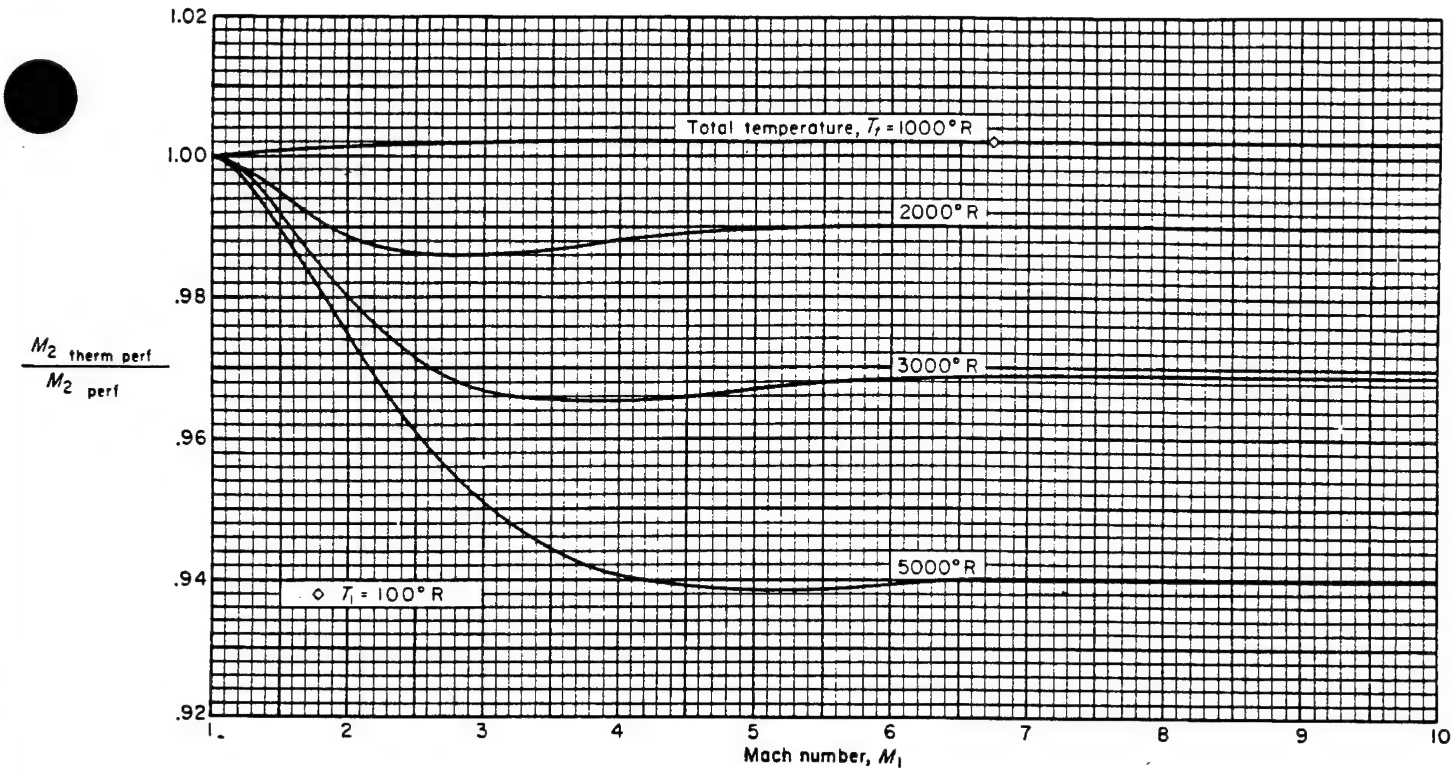


CHART 19.—Effect of caloric imperfections on the Mach number downstream of a normal shock wave.

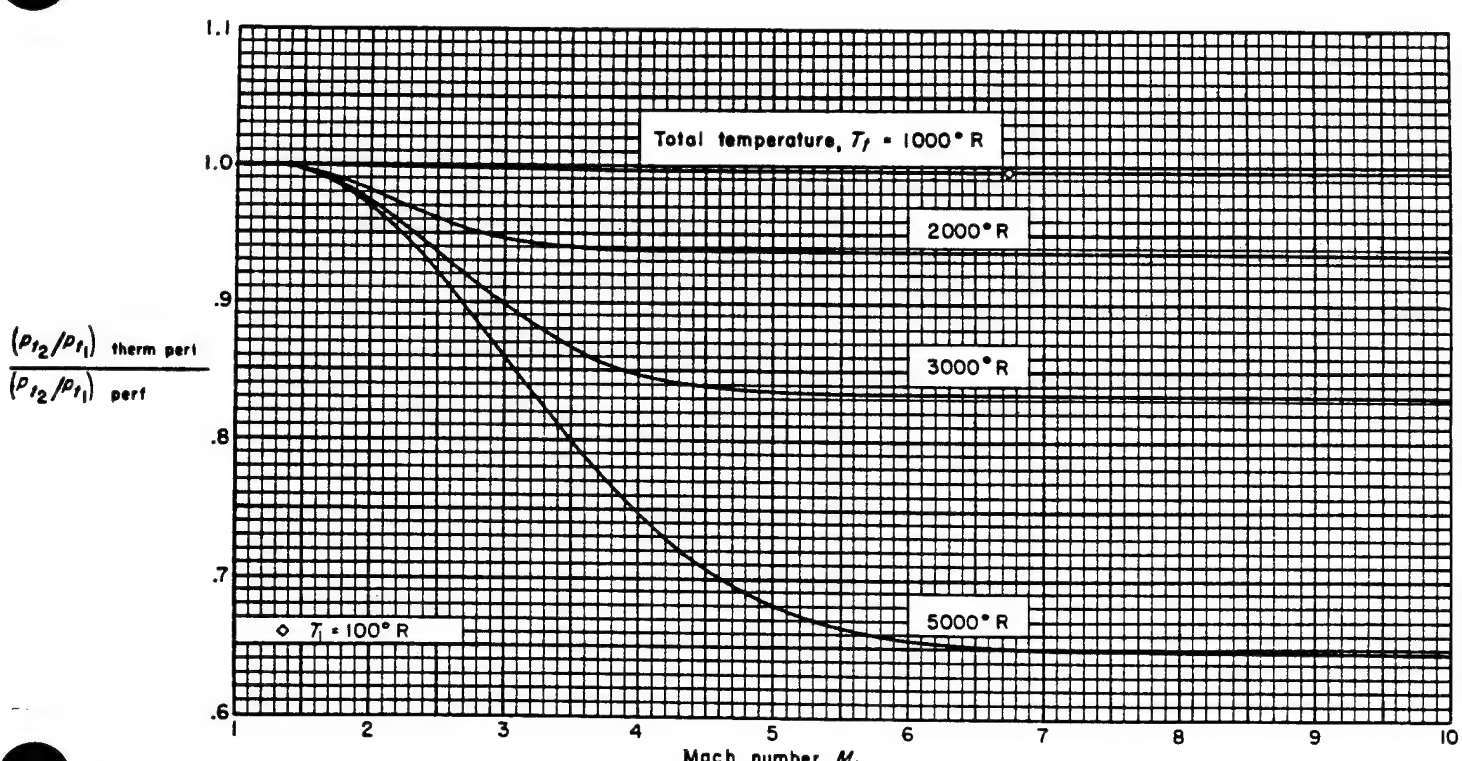
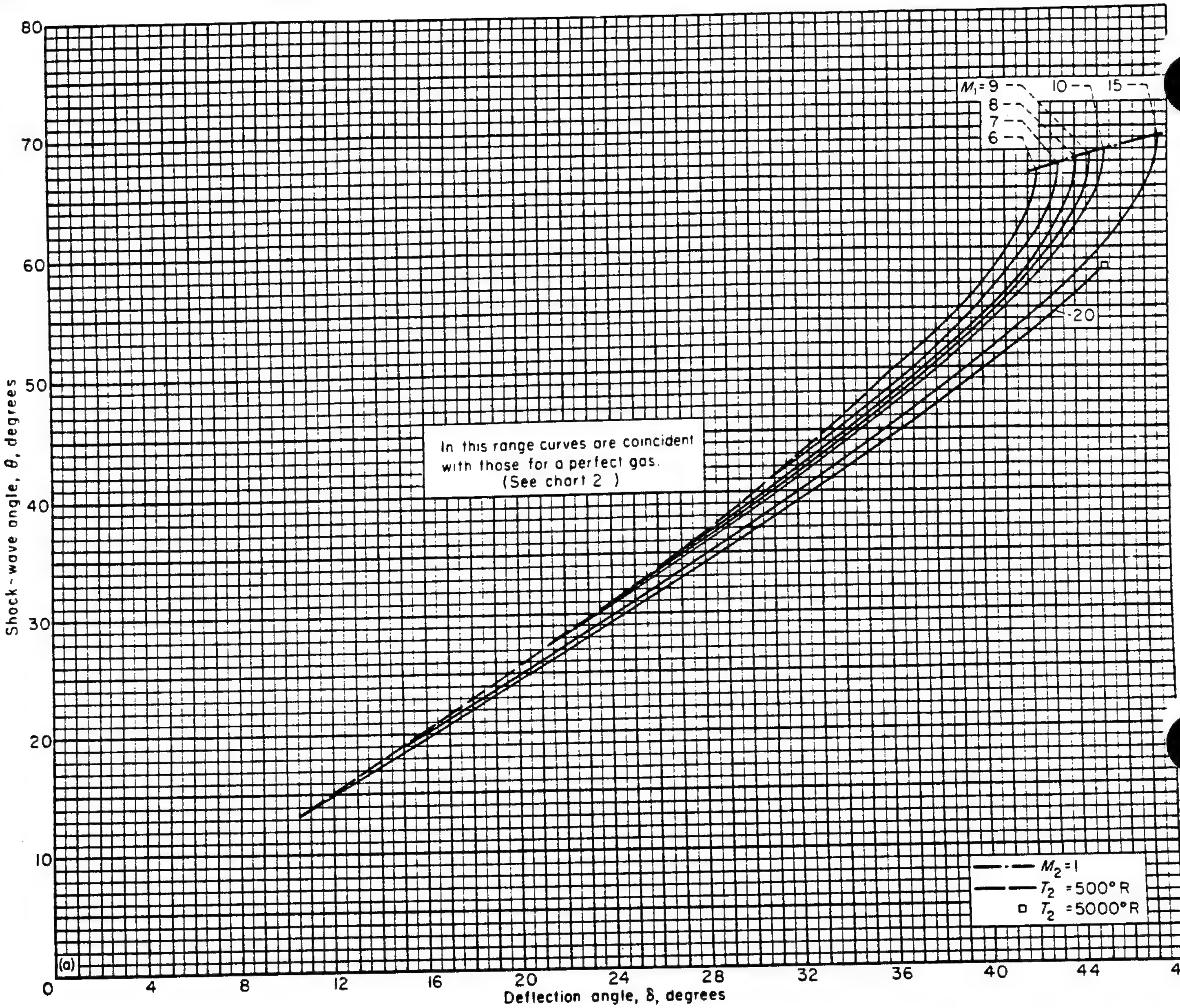
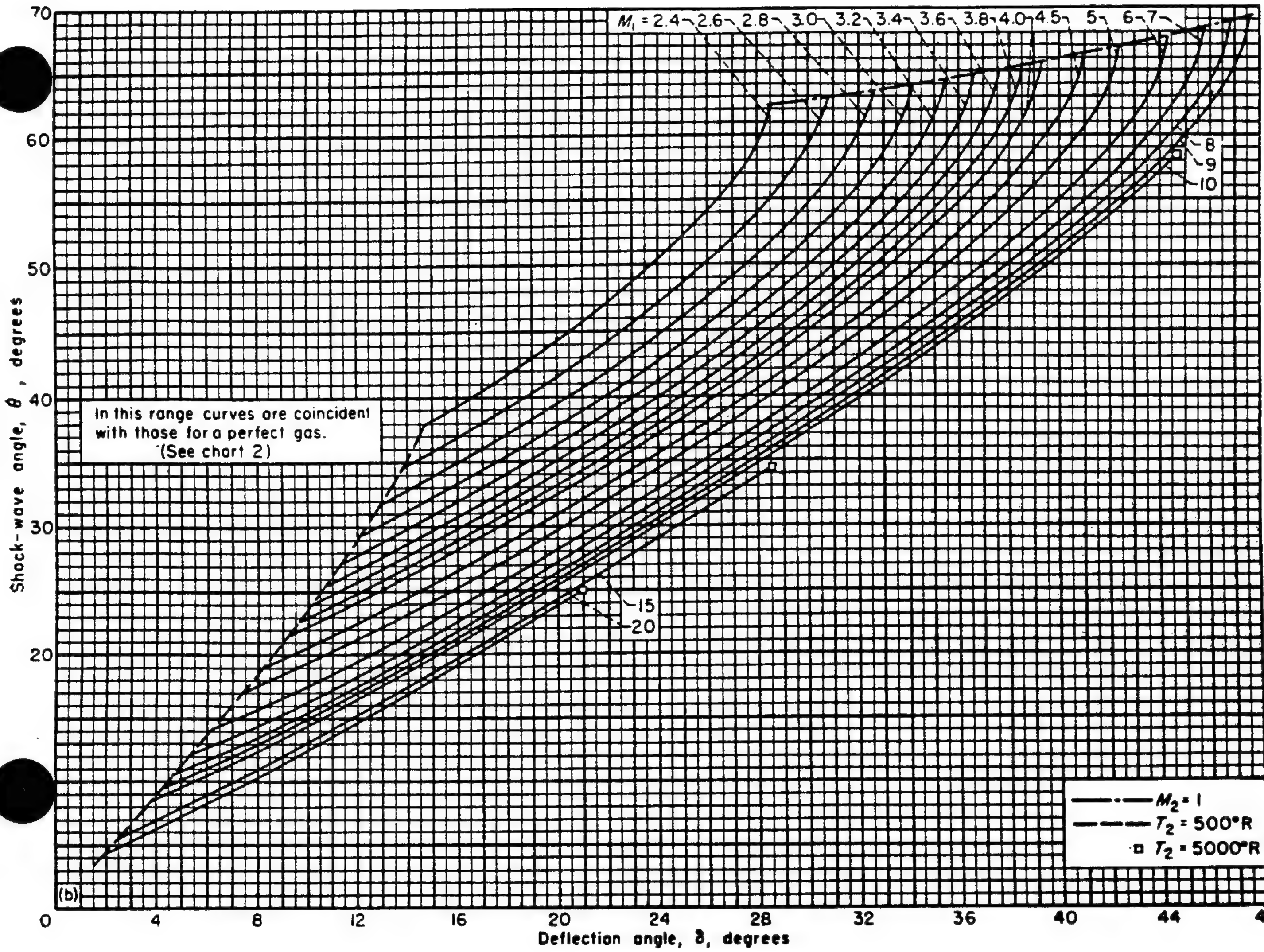


CHART 20.—Effect of caloric imperfections on the total-pressure ratio across a normal shock wave.



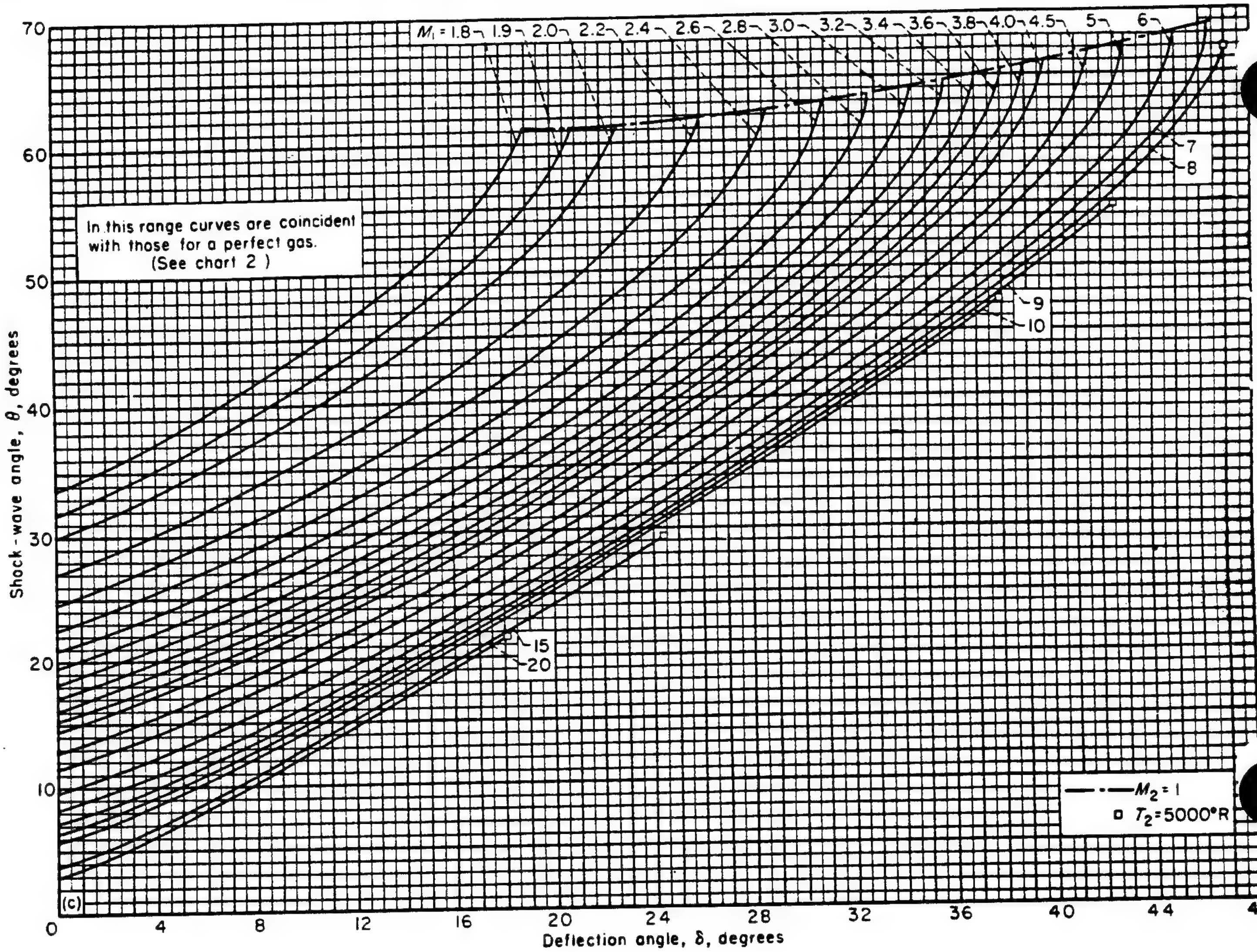
(a) $T_1=100°$ R

CHART 21.—Effect of caloric imperfections on the variation with flow-deflection angle of the shock-wave angle for a weak oblique shock wav



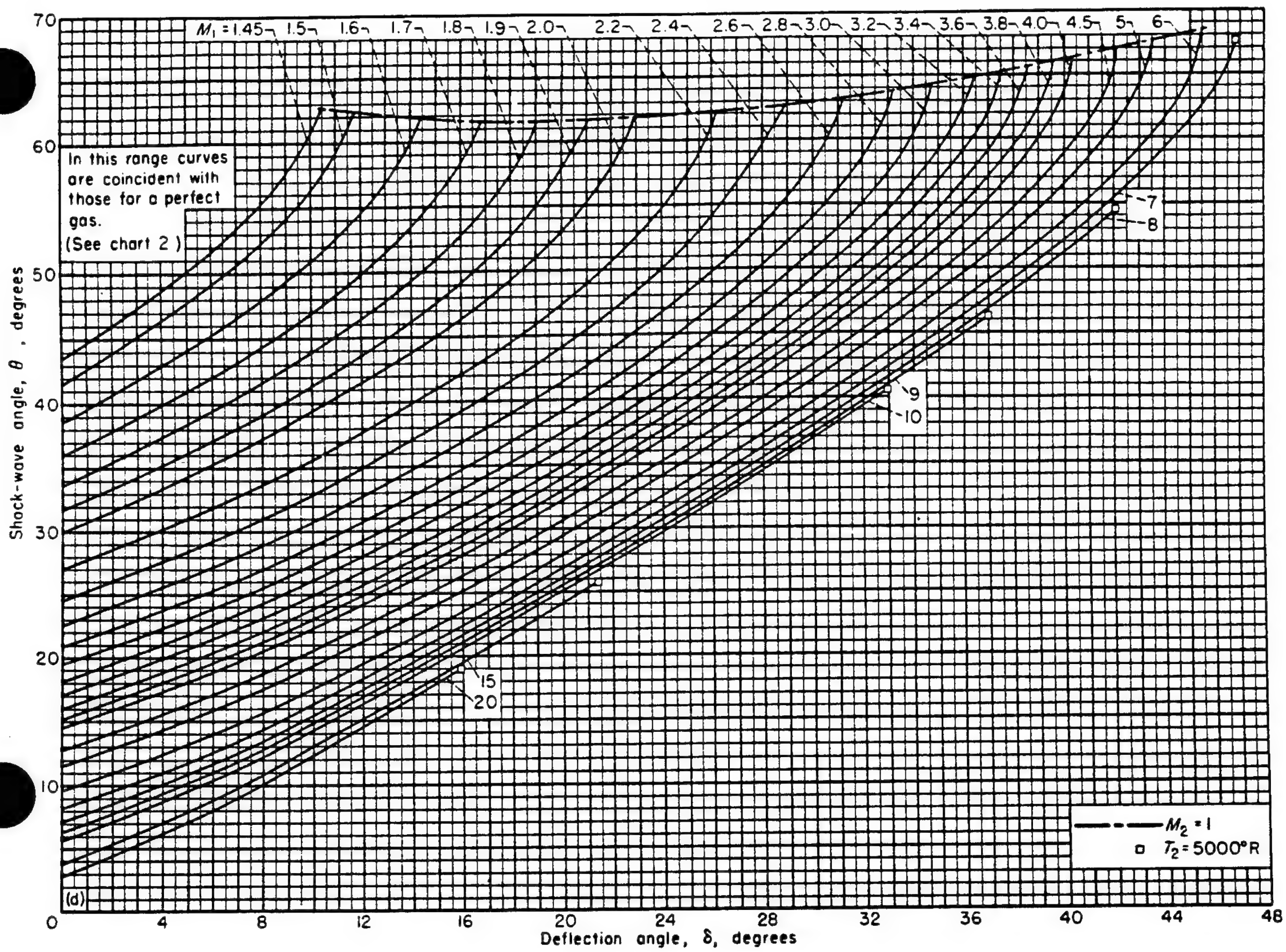
(b) $T_1 = 390°$ R

CHART 21.—Continued



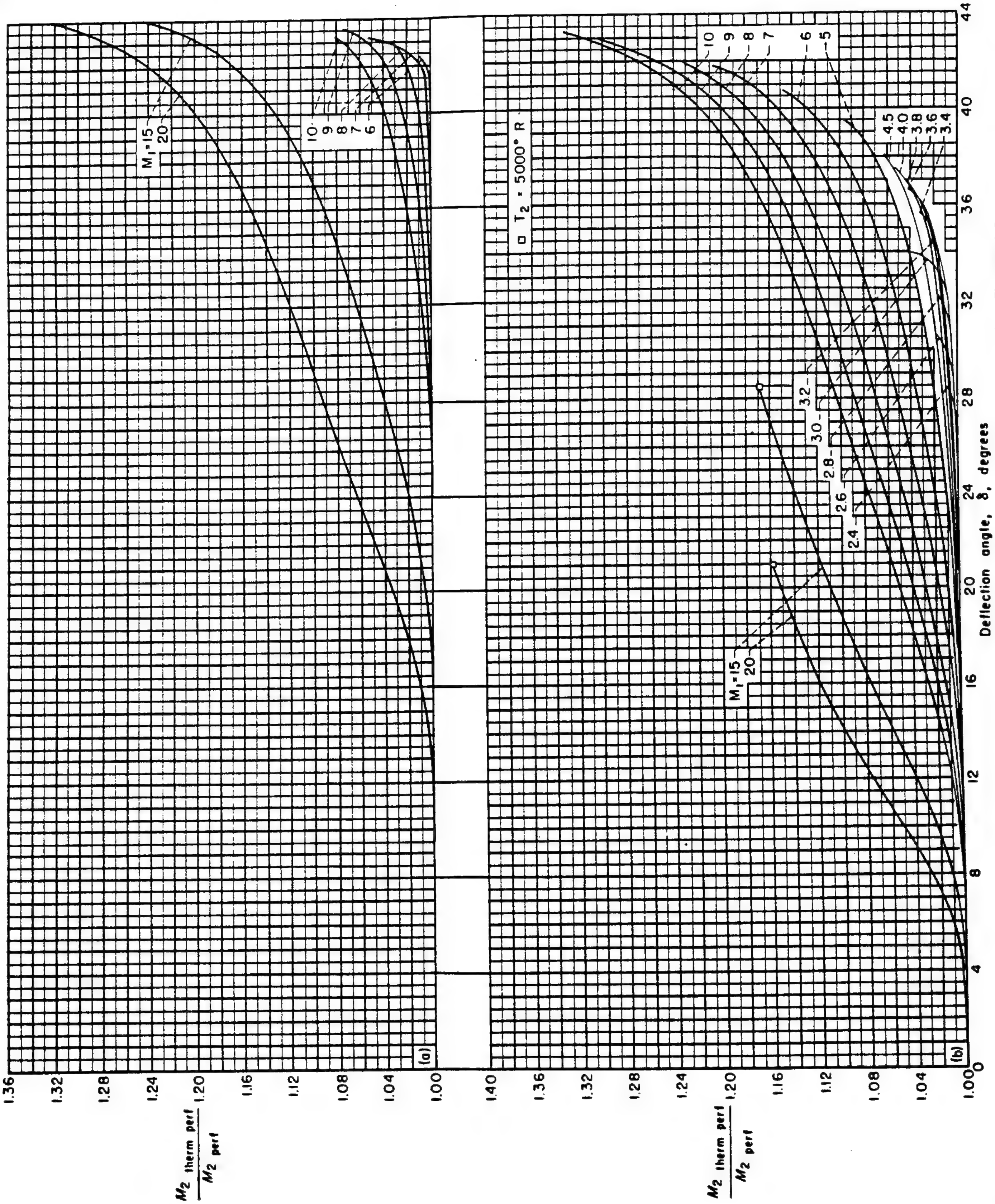
(c) $T_1 = 500°$ R

CHART 21.—Continued



(d) $T_1 = 630°$ R

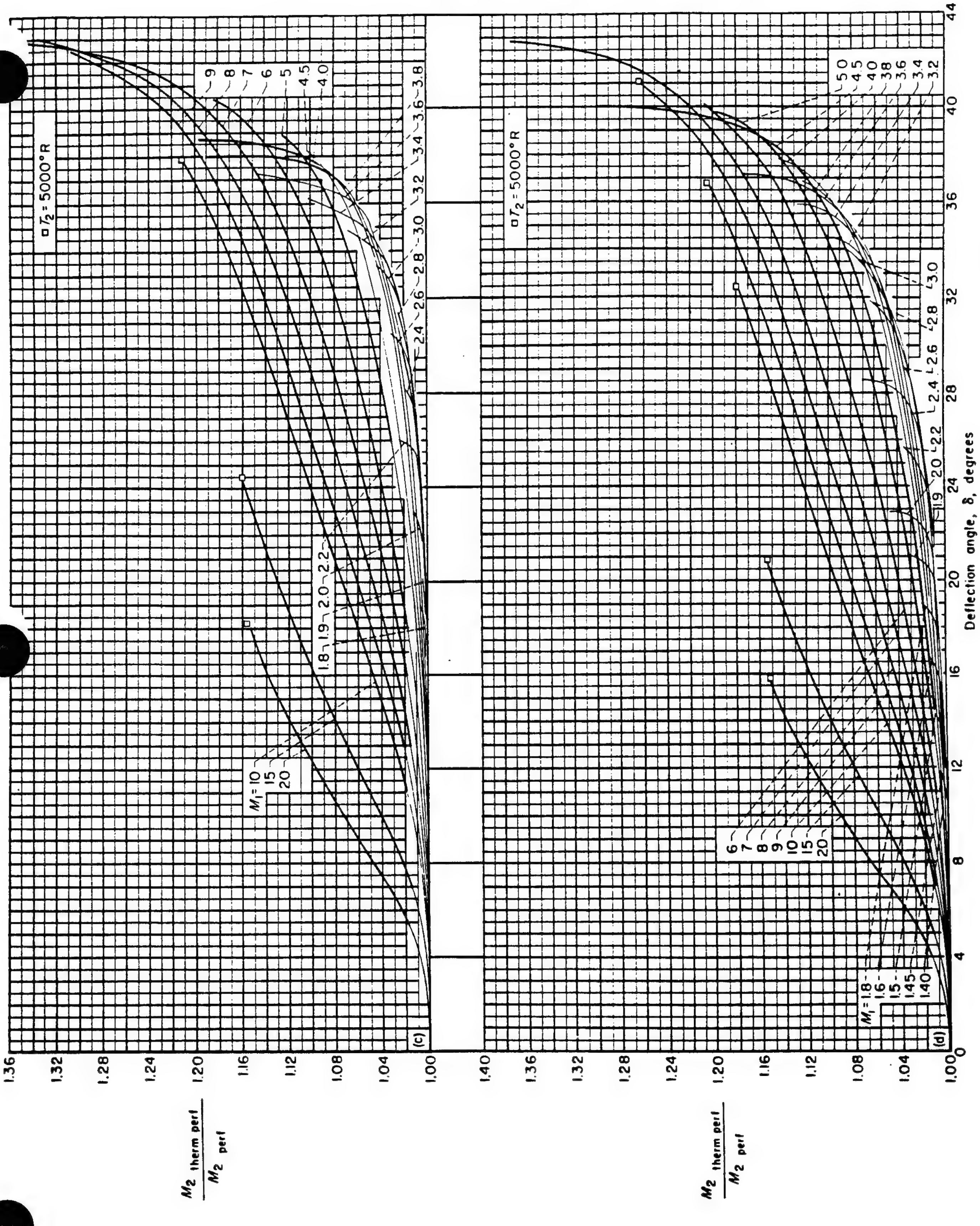
CHART 21.—Concluded



(a) T_1=100° R

(b) T_1=390° R

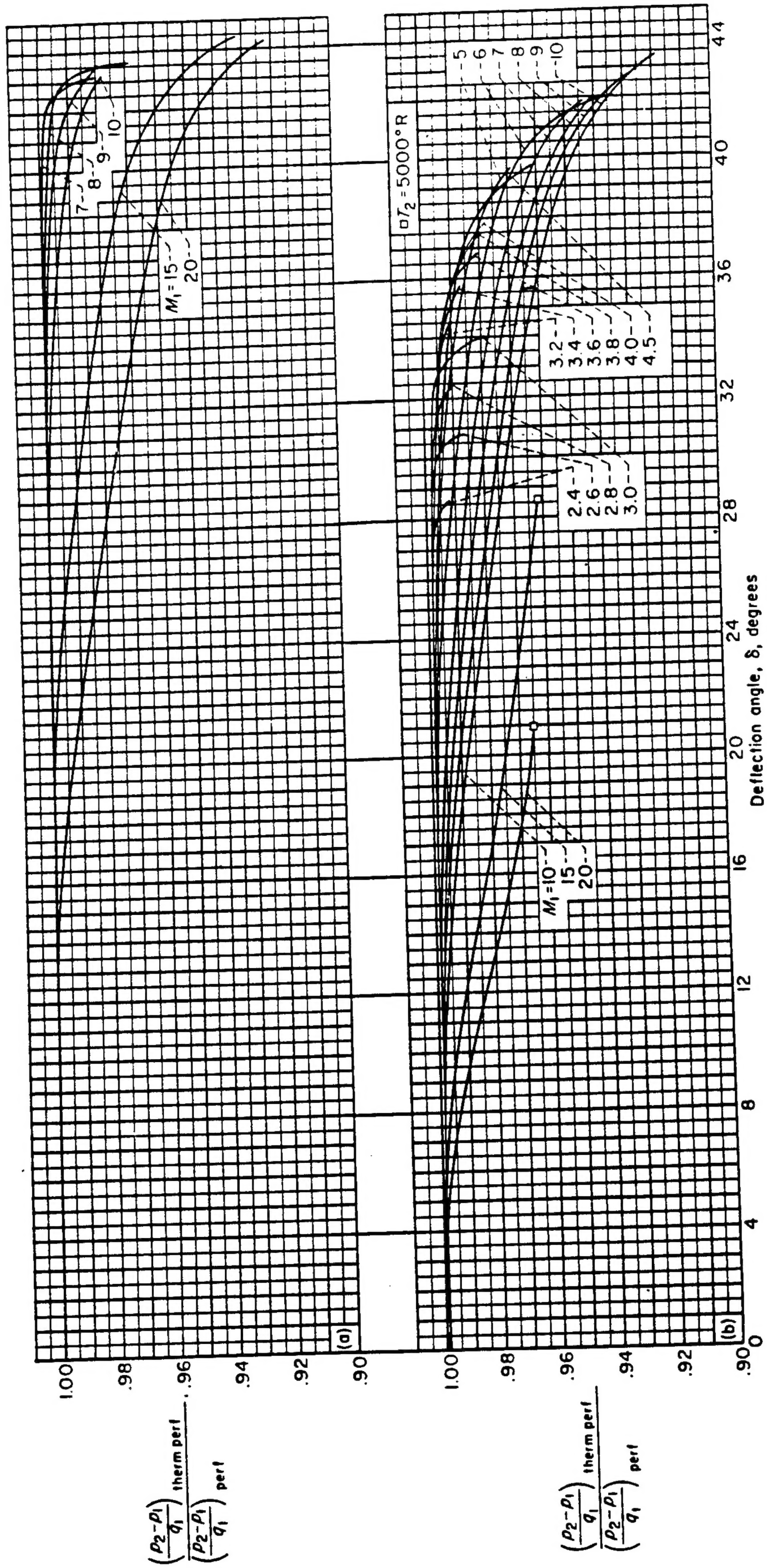
CHART 22.—Effect of caloric imperfections on the variation with [illegible] ection angle of the Mach number downstream of a weak oblique shoc[illegible]



(c) $T_1 = 500°$ R

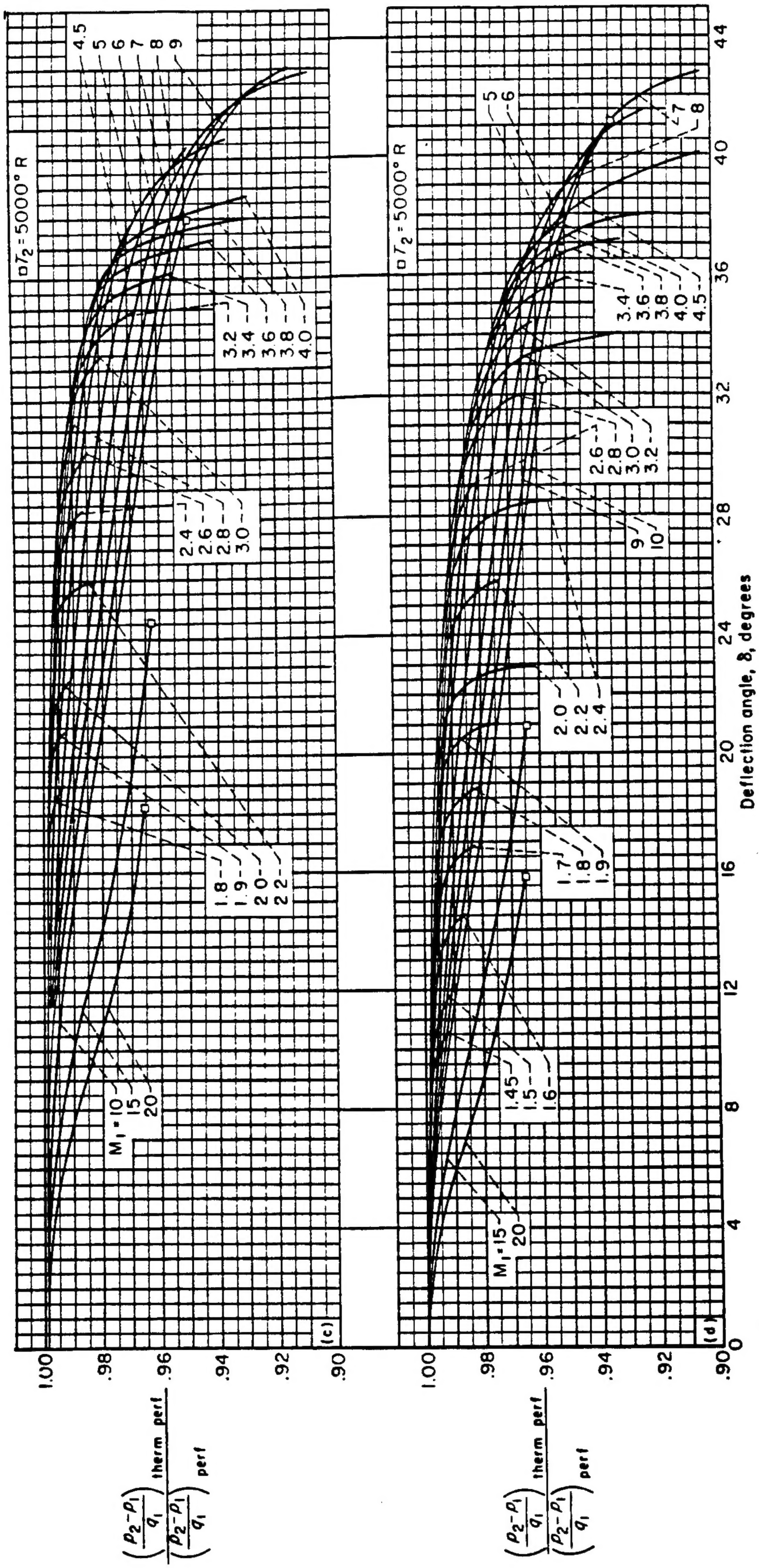
(d) T_1 630° R

CHART 22.—Concluded



(a) $T_1=100°$ R
(b) $T_1=390°$ R

CHART 23.—Effect of caloric imperfections on the variation with flow-deflection angle of the pressure coefficient across a weak oblique shock wave.



(c) $T_1 = 500°$ R
(d) $T_1 = 630°$ R
CHART 23.—Concluded

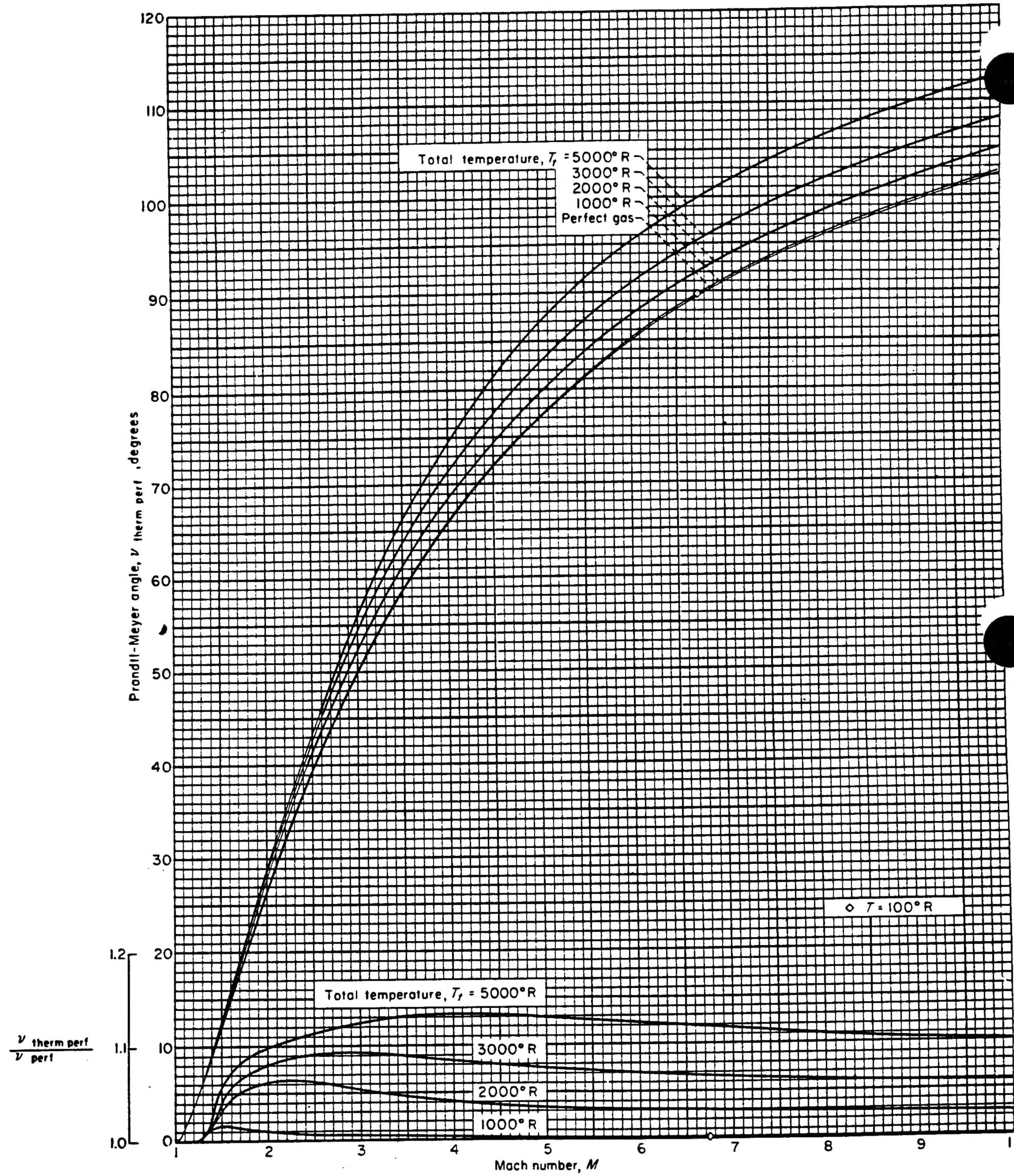


CHART 24.—Effect of caloric imperfections on the Prandtl-Meyer angle.

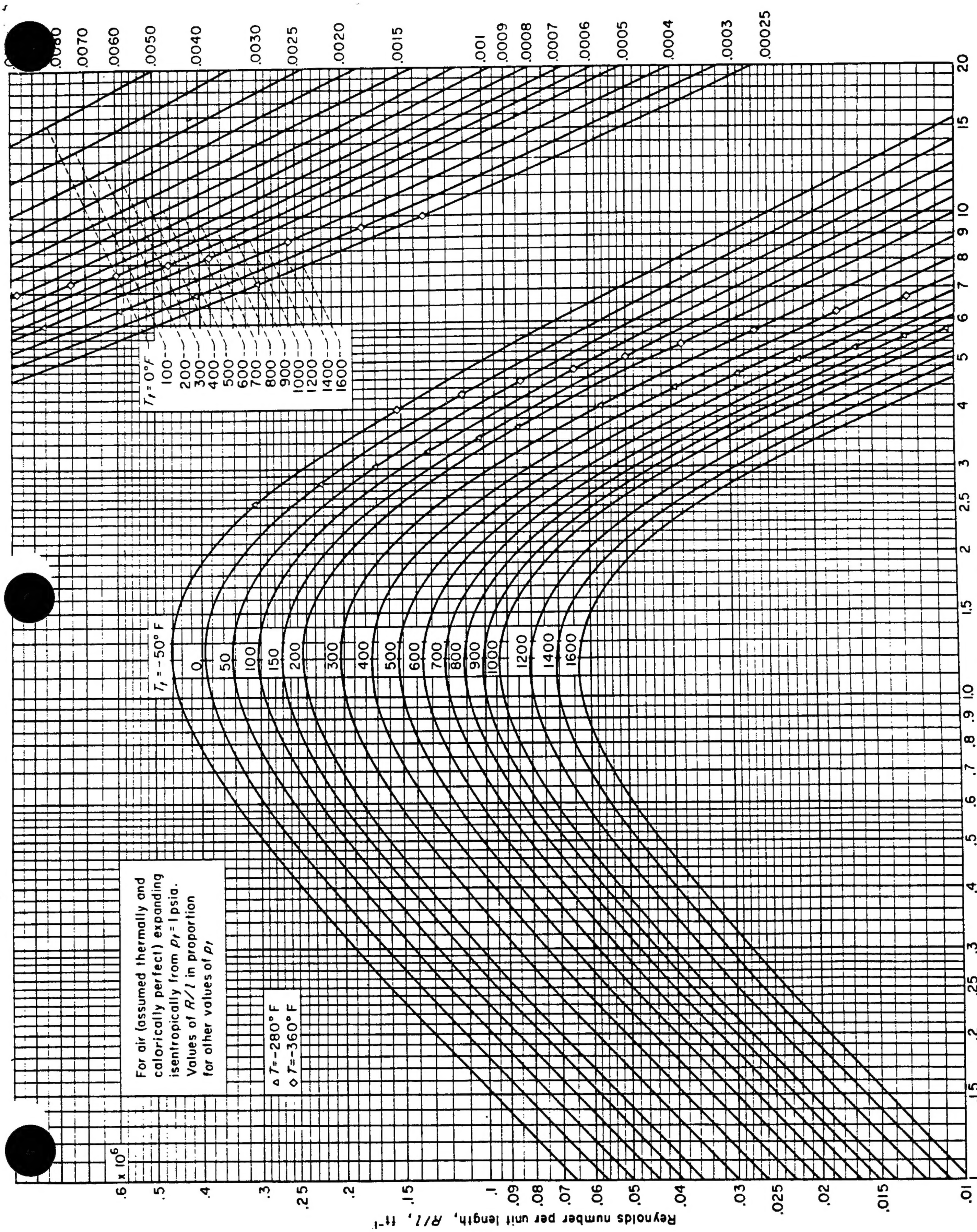


CHART 25.—Variation of Reynolds number per unit length with Mach number for various total temperatures. Perfect gas, $\gamma = 7/5$.

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